(Established 1832).

AMERICAN ENGINEER AND RAILROAD JOURNAL.

SEPTEMBER, 1907

A RATIONAL APPRENTICE SYSTEM.

NEW YORK CENTRAL LINES.

Synopsis.

PART II.

Entrance Qualifications.

Applicants for employment as apprentices must be not less than 17 or more than 21 years of age; preference is given, as far as possible, to the sons of employees. The applicant must pass a medical examination before the local medical officer, at the company's expense, proving him to be sound physically and mentally. His sight must be not less than 20/30 in each eye, he must be free from color blindness and his hearing must be not less than 20/20.

The applicant must have a good common school education, sufficient to enable him to read and write the English language and to make out his application on the blank provided for that purpose. He must have had sufficient training in simple arithmetic to enable him to do problems in addition, subtraction, multiplication and division of numbers to four figures and must have a reasonable knowledge of common and decimal fractions.

Credit in rate and time, not to exceed two years, may be given for previous work of the same class as that covered by the apprentice course. This credit, however, can only be given after the written approval of the superintendent of apprentices has been secured. The college graduate is given a time allowance for the work done in the college shop or during his summer vacation.

Applicants not showing an adaptability for the work should be dismissed from the apprentice course during the first six months and may be transferred to other employment.

The apprentices are selected from among the applicants by the chief officer of each shop in conjunction with a representative of the apprentice department. At one or two of the shops the applicant is given a written examination, but this is not encouraged. It is believed that the boys may be better sized up and that more satisfactory results are obtained by having the instructors engage the applicant in a simple conversation rather than by giving him a formal examination.

Examinations.

Examinations either for entrance or at any time during the course or at its completion are discouraged. The instructor, if he is the right kind of a man, can keep in such close personal touch with the boys that he knows far more as to their standing than could be determined by any formal examination. The courses are arranged so that a boy cannot successfully carry on the work unless he is thoroughly familiar with each step and the instructor has no trouble in determining whether he is qualified to take advance work or should be given additional exercises other than the problems which had been laid out in the regular course.

The success of this system of education depends largely on both of the instructors keeping in close personal touch with the apprentices and if a boy does not make an earnest effort to keep up with his work and take a reasonable interest in it, he is very soon detected and dropped from the service. On the other hand, some of the boys who may make the very best workmen in some branches have great difficulty in becoming proficient in certain parts of the work in the problem and drawing courses, but if they make an earnest effort and do good work in other respects their deficiency in this part of the work is overlooked.

Blackboard Exercises.

At frequent intervals the members of the class are sent to the blackboard, preferably just after the opening or just before the close of the session. The boys are given slips or cards containing the problems and thus each may have a different one. The instructor from the middle of the room, with the aid of a key, can easily and quickly determine whether the problems are worked out correctly, and as fast as one is completed can assign another. As the greater part of the problem work is done on the boy's own time, outside of school hours, these blackboard exercises enable the instructor to determine whether the boys are getting as much as they should out of their problem work and to see whether they really understand the work. By watching them carefully he can easily see which ones need help and where they are weak.

Because of the difference in the advancement of the boys in the working out of the problems it may not be feasible to send them all to the board at the same time, and if so, different sections may be sent to the board at different times, although the instructor, who knows just what problem sheet each boy is working on, can have the entire class go to the board at one time and give each apprentice examples of a grade to suit his requirements.

Lectures.

Lectures, in the sense in which the word is used in connection with college work, are not appreciated by the apprentices. Occasionally it is desirable for the instructor to take up certain features of the work with the class as a whole, but care is

N. Y. C LINES.
RECORD CARD APPRENTICE SYSTEM.

NAME. Harry H. Smith.
SHOPS AT West Albany. N.Y.C.& H.R.R.R.

YEAR	1903-1904						1904-1905						1905-1906						1906-1907					
MONTH.	CLASS OF WORK.	DAYS WORKED.	RATE.	WORKMANSHIP.	PERSONALITY.	CLASS WORK.	CLASS OF WORK.	DAYS WORKED.	RATE.	WORKMANSHIP.	PERSONALITY.	CLASS WORK.	CLASS OF WORK.	DAYS WORKED.	RATE.	WORKMANSHIP.	PERSONALITY.	CLASS WORK.	CLASS OF WORK.	DAYS WORKED.	RATE.	WORKMANSHIP.	PERSONALITY.	CLASS WORK.
4	General	24	8	4	C	C	Lathe & Miller	24	10	6	C	C	Air Brake	25	12	6	C	C	Motion Work	25	14	7	B	C
5	Mach. Work	27		4	C	C	Slotter	25		6	C	C	" "	30		6	C	C	" "	30		7	B	C
6	" "	26		5	C	C	"	26		6	C	C	" "	24		7	C	C	" "	24		7	B	B
7	Drill Press	10		5	C	C	"	25		6	C	C	Steam Pipes	25		6	C	C	Guide and Steam Chest	12		7	B	B
8	" "	28		5	C	C	Tire Lathe	26		5	C	C	" "	26		7	C	C	Boiler Head Driving Boxes	26		7	B	B
9	" "	26		5	C	C	" "	24		6	C	C	" "	24		7	B	C	" "	24		7	B	B
10	Jumper	27		5	C	C	" "	30		6	C	C	General Pit Work	24		7	B	C	" "	30	16	7	B	B
11	"	23		5	C	C	Planer	28		6	C	C	" "	30		7	B	C	" "	28		7	B	B
12	"	28		5	C	C	"	27		6	C	C	" "	28		7	B	C	Round House	27		6	B	B
1	Bolt Lathe	28		5	C	C	"	30		6	C	C	Shoes & Wedges	27		7	B	C	" "	30		7	B	B
2	Lathe & Miller	22		6	C	C	Tool Room	25		6	C	C	" "	30		7	B	C	" "	26		7	B	B
3	" "	25		6	C	C	" "	26		7	C	C	" "	25		7	B	C	" "	25		7	B	B
TOTALS AND AVERAGES	YEAR COMPLETED Mar. 31, 1904						Mar. 31, 1905						Mar. 31, 1906						Mar. 31, 1907					
EST. OF STUDENT	Steady - Reliable. Rather slow. Lacks confidence.						Will make a good man						Attended Eve. Class.						Marked improvement in class work. Judgement - Good.					

APPRENTICESHIP COMPLETED March 31, 1907

MARKS FOR 4 YEARS { WORKMANSHIP - 6. PERSONALITY - B CLASSWORK - C.

WORKMANSHIP MARKS. REPORTED BY SHOP INSTRUCTOR. BASIS - 10 TO 1. (WHERE 10 IS PERFECT)

PERSONALITY MARKS. REPORTED BY SHOP INSTRUCTOR. BASIS - A. B. C. (SEE BELOW)

CLASS WORK MARKS. REPORTED BY DRAWING INSTRUCTOR. BASIS - A. B. C.

ESTIMATE OF STUDENT REPORTED BY INSTRUCTORS. (YEARLY REPORT)

A - EXCELLENT.
B - GOOD.
C - FAIR.
D - UNSATISFACTORY
E - FAILURE.

SUBSEQUENT SERVICE

Re-employed as Machinist at Depew Shops, April 15, 1907

REPRODUCTION OF ONE OF THE APPRENTICE'S RECORDS.

taken at such times to cover only a small amount of ground, taking up one or two points only, to make the explanations clear and simple and to make the talk as informal as possible, asking the boys questions and carrying it on in a conversational style.

The apprentice department has secured a combination stereopticon and reflection lantern, which it is proposed to use in connection with the evening classes, and as the work becomes more advanced, it is expected that it can be used to advantage in connection with the regular apprentice classes.

At practically all of the schools the apprentices have had the benefit of instruction in the air brake instruction car or room.

Preparations are being made for a series of evening talks at the West Albany shops, which will be open to the apprentices and members of the mechanics' evening classes. The first talk of the series will be on the electric locomotive by Mr. J. G. Bauket, assistant superintendent of electrical equipment. This same plan will probably be worked out at the other schools.

Discipline.

The deportment of the apprentices, both in the school room and in the shop, is good. As they are paid for the time in the school room it is possible to enforce a strict discipline if necessary, although generally speaking the boys are so thoroughly interested in their work that the instructor has very little difficulty as concerns their conduct. Cases of poor deportment or unexcused absence from class are reported to the shop superintendent, and if necessary he takes the matter up with the offender. "Boys will be boys," and except in extreme cases more can usually be accomplished by directing their efforts to better things rather than by strictly enforcing a penalty or attempting to punish them. At the close of the school session the apprentices go directly to their work in the shop. The shop instructor usually assists in the class room and he sees that the boys report promptly to the shop.

The reports covering the apprentice's deportment, personality, and scholarship, which are considered in detail in the following section, are kept on record at the local shop and at the New York office, and are periodically reviewed by various officers, so that it is of course to the apprentice's advantage to see that these reports are as favorable as possible.

Records and Diplomas.

The record of each apprentice, from the time he enters the service until he completes his apprenticeship, is kept on file at the apprentice headquarters in New York, as well as at the local shop. Heavy cardboard cards, 8 x 10½ in. in size, are kept on file at the New York office, one side showing the record of the apprentice for each month, extending over a period of four years, and the other side giving general information as to his record. Both sides of one of these cards are reproduced. At the end of each week of service the shop instructor makes a record of the workmanship and personality of each apprentice, and the drawing instructor makes a record of the drawing room and class work. The monthly report is taken from these records.

The mark on workmanship is based on the quantity and quality of the work done in the shop and upon the skill and ability shown. The mark ten indicates perfect work; nine is not as good, and so on down to zero, which is the lowest.

The drawing room and class work mark is based on both the quantity and quality of the work done and on the apprentice's attitude toward his studies. The first five letters of the alphabet are used as follows:

A—Excellent, exceptionally good, to be given sparingly.
B—Good, better than the average, should be given only where there is special merit.
C—Fair, the average mark, and the one to be most commonly used.
D—Unsatisfactory, below the standard, means that improvement must be made.
E—Failure.

The personality mark is based on the attitude of the apprentice toward his work, his interest, evidence of ambition or lack of it, whether he is doing his best, his willingness to be instructed and his general character and habits. The first five letters of the alphabet are used as above.

The apprentices may learn their monthly marks by applying to the instructor at stated intervals. At the end of each year each apprentice receives a report showing his average marks for the year.

N. Y. C. LINES.
RECORD CARD APPRENTICE SYSTEM.

NAME Harry H. Smith
SHOPS AT West Albany N.Y.C. & H.R.R.R.

NAME Harry H. Smith BORN 1-4-1885. AT Troy.
PRESENT ADDRESS (IN FULL) 19 Main St. Albany N.Y.
LIVING AT HOME OR BOARDING Home PARENTS OCCUPATION Engineer
EDUCATION. YEARS IN GRAMMAR SCHOOL All. COURSE COMPLETED Yes
YEARS IN HIGH SCHOOL 1. EVENING COURSES ATTENDED Nine.
YEARS SINCE LEAVING SCHOOL BEFORE STARTING AS APPRENTICE 2
PREPARATION IN ARITHMETIC All ALGEBRA Simple Equations.
OTHER SUBJECTS —

ENTERED SERVICE Dec. 1902 AT Ravena AS Round House Helper.
RATE 16 SERVICE TERMINATED March 31, 1907.
SUBSEQUENT SERVICE —

COMMENCED APPRENTICESHIP April 1, 1903. CLASS Machinist.
COMPLETED APPRENTICESHIP
REMARKS Father employed as engineer 6 years.
Uncle, painter in car shops, 10 years.
Made captain of apprentice ball team, 1905-6.

REAR SIDE OF REPORT OR RECORD CARD.

At the end of each year the instructors draw up an estimate of the personality and progress of each apprentice. This is made up of the answers to the following questions, the first six of which are to be answered by the words "yes" or "no.":

1. Does he work overtime on drawing or problems?
2. Is he the type of boy we wish to have in our employ?
3. Is his attitude toward his employers good?
4. Does he spend his time well outside of shop hours?
5. Have you, or has the shop instructor, succeeded in gaining his confidence; *i.e.*, would he come to you first in trouble of any kind?
6. Can you recommend him at present to start in the company drafting room, or will he qualify during the next year? (Give probable date.)
7. What is his strongest point, or for what type of work is he best fitted?
8. What is his weakest point, or for what type of work is he least fitted?
9. Does he live at home, or board?
10. What is his address?

In addition to this information the instructor is expected to call attention to any items of interest such as special work which has been done by the apprentice, conditions at home, handicaps, or any facts which might be used in recommending a boy for a position. This report is not expected to be in any way based upon the monthly reports which are sent in by the instructors, but it is expected to be the instructors' personal estimate of the apprentice. The report is not supposed to be official and is not made through the local officer, but is sent directly to the superintendent of apprentices.

When the apprentice has completed his course he is presented with a certificate, which is suitable for framing, and which is reproduced on a small scale in the accompanying illustration.

Incentives to Promote and Hold Interest.

There are many incentives to encourage the apprentice in his work. The drawing and problem courses are made as interesting as possible; they deal with no abstract theories, but all of the exercises and problems are in connection with practical work in the shop. In most instances there is more or less rivalry among the apprentices as to their progress in this work.

In connection with the annual estimate of the personality and progress of each apprentice the instructors are asked to make special mention of those who have made exceptionally good progress or who have distinguished themselves either on some special piece of work or in class work. The superintendent of apprentices writes a personal letter of commendation to each of these boys and naturally these letters are very highly prized by the recipients. On New Year's Day of this year 45 such letters were sent out.

As an additional incentive it is quite probable that, after the schools have been established for a long enough period so that the apprentices will have been able to complete the course in drawing and problem work, a few of the brighter graduate apprentices will be sent, at the company's expense, to a technical school for a year to finish off their course. Such men will be admirably prepared for work in the motive power department.

At most of the shops the apprentices who show a liking for mechanical drawing are assigned for a month or two, during their apprenticeship, to assist the shop draftsman and usually the apprentice is allowed to place his name on all the drawings he makes. These are of course commented upon when they come to the attention of the men in the shop and the boys take more or less pride in having done such work. In several instances apprentices who have made especially good records and have about completed their apprenticeship are given the privilege of being transferred to the main drawing room of the road and in a couple of instances the boys have been sent to the main drawing room at New York after they have completed their course.

At two of the shops the apprentices have been taken in a body, under the direction of the instructors, to visit neighboring shops or large manufacturing establishments, for instance, at the West Albany shops the apprentices have visited both the American Locomotive Works and the General Electric Company's works at Schenectady.

At some of the smaller shops where the boys are not able to round out their courses to advantage they will be assigned to

larger shops for the fourth year, for instance, the boys in the car department at East Buffalo will probably have an opportunity of spending a year at the West Albany shops in order to get experience in repairing passenger cars.

The shop superintendents encourage the boys by occasionally assigning them to special work where they can apply the knowledge in drawing or mathematics, which they have gained in the class room. One shop superintendent, who is very much interested in the apprentices, makes a point of occasionally stopping and asking an apprentice something about the work which he is doing that will make him appreciate the application of what he is learning in the class room.

Attitude of the Men.

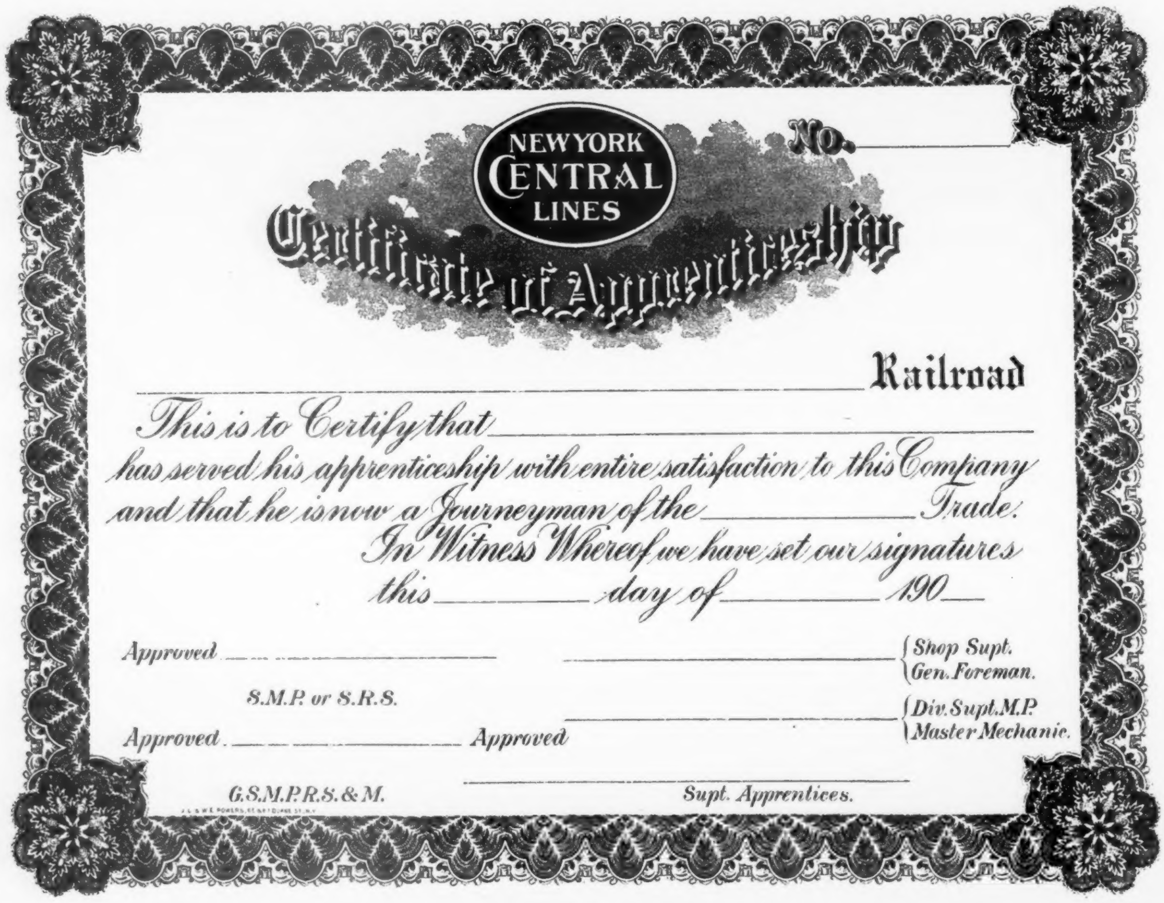
The workmen are taking a great deal of interest in this new development and look upon it with considerable favor. There has been very little incentive during the past few years for boys to enroll as apprentices, and the men are glad to have an opening for their sons by which they can be assured of a thorough training which will make them first-class mechanics, and which if properly followed up may fit them for positions of authority and responsibility. Due to the neglect of a proper system for recruiting men the percentage of skilled mechanics has been very sadly decreased and the good all-round mechanic has almost been lost sight of. A system that will build up men of this kind, and thus add dignity and importance to the position of the mechanic, is to be welcomed.

Attitude of the Officers.

The officials, from the gang boss to the superintendent of motive power, seem to be very much pleased with the new system. It means that they are going to have more efficient men under them and that the problem of issuing and executing orders will be simplified. The boys, coached by the shop instructor, are doing better work and more of it, and the amount of spoiled work, which is always an item where there are many boys in the shop, is being reduced to a minimum. The problem of securing and holding apprentices has been solved, and in a few years the problem of securing good all-round mechanics will, to some extent at least, also be solved. A point blank question addressed to various officials, as to whether such a system was worth while and really paid, was met by a very enthusiastic response that of course it did, and in most cases they were ready to advance good reasons as to why this was so.

It is interesting to note the attitude of different officials as they enter the school room when a class is in session. One superintendent of motive power always promptly removes his hat, as he considers that the school room is on the same plane as a college recitation room and deserving of the same respect and dignity.

At every point questioning brought out the fact that the higher officials quite often stop in at the school room and usually examine the work the boys are doing, occasionally asking questions or in some way showing their interest in the work. It is these little things, that are so easy to do and yet so easy to be left undone, that impress and encourage the boys.



NEW YORK CENTRAL LINES

No. ________

Certificate of Apprenticeship

________________________ Railroad

This is to Certify that ________________________
has served his apprenticeship with entire satisfaction to this Company
and that he is now a Journeyman of the ____________ Trade.
In Witness Whereof we have set our signatures
this ________ day of ________ 190__

Approved ________________ ________________ Shop Supt. / Gen. Foreman.

S.M.P. or S.R.S.

Approved ________________ Approved ________________ Div. Supt. M.P. / Master Mechanic.

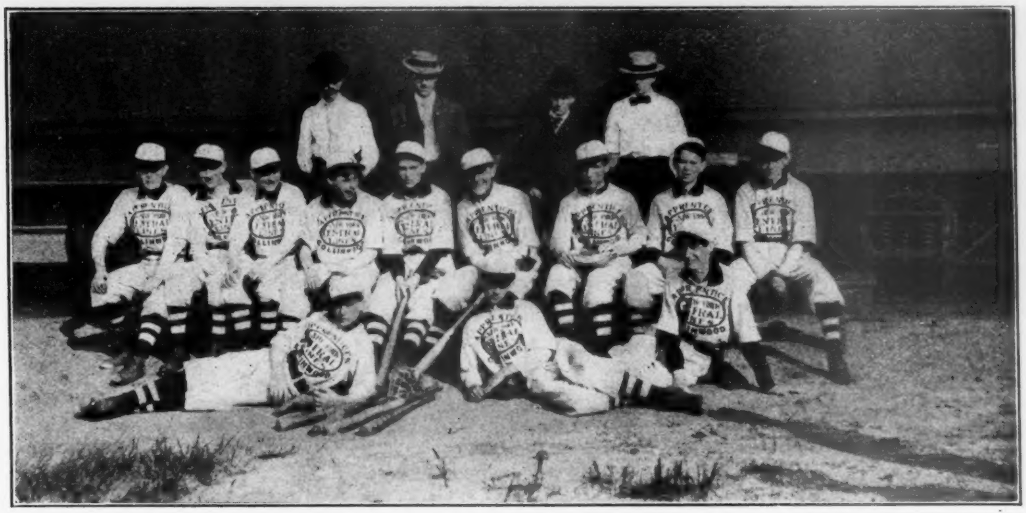
G.S.M.P.R.S.&M. ________________ Supt. Apprentices.

REDUCED FACSIMILE OF DIPLOMA.

The Car Department.

It has usually been considered impossible to maintain an apprentice system in the car department and recruit the force, other than the laborers and helpers on the repair track, from its ranks, and this is especially true where freight car work only is handled. That an apprentice system has been established at East Buffalo, a point where up to the present time only freight car repair work has been done, is worthy of notice. It was said to be impractical to introduce such a system at that point, but at the present time there are five regular apprentices and the indications are that this number will be considerably increased in the near future.

In starting this school a number of laborers and helpers were collected together and were guaranteed a special course if they would enroll themselves in the school and attend its sessions. Many of them realizing the advantages to be thus gained enrolled themselves, and with this start made it was not a difficult matter to secure apprentices because of the advantages which



APPRENTICES' BALL TEAM—COLLINWOOD SHOPS.

were offered. On May 1 there was one blacksmith, one tin and coppersmith, two machinists and one carpenter apprentice in addition to thirteen laborers who were enrolled in the school.

Special courses, both drawing and problem, have been arranged, although a considerable part of the work in the locomotive courses is suitable for the car department apprentices.

Apprentice Auxiliaries.

At several of the shops the apprentices have formed organizations of their own for social purposes. The boys at Oswego have organized and started the custom of having an annual dinner. The first one was given on April 23 of this year and to it were invited the superintendent of apprentices and his assistant from New York, the superintendent of motive power at Oswego, Mr. W. O. Thompson, and the various foremen in the mechanical department. Short addresses were made by the invited guests and by some of the boys and the evening passed off very successfully.

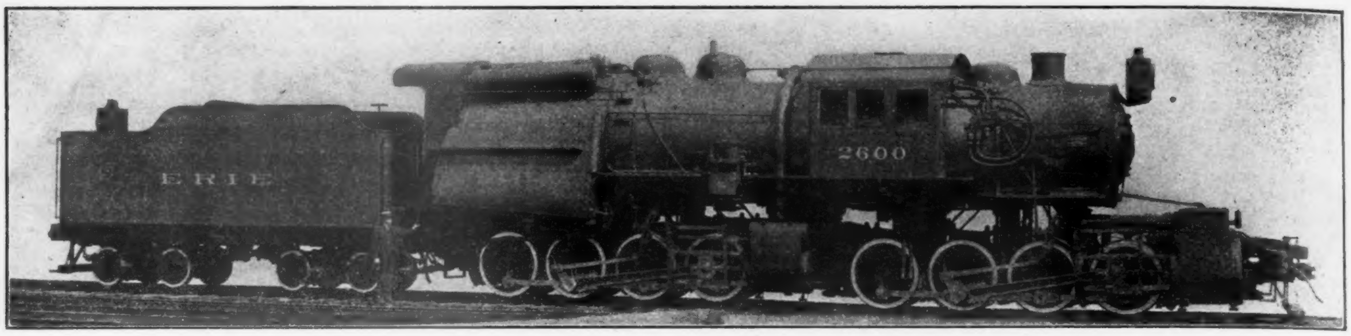
At Elkhart the apprentices have an organization and each year arrange for a camping trip. This is also true of the West Albany shops. The apprentices at Elkhart and Collinwood have organized ball teams. At Collinwood a diamond has been laid out on the shop property. Two games have been played between the Collinwood and Elkhart teams, and the Collinwood team has had a game with the shop officials.

It is expected that an apprentice button will be worked up which the apprentices on the system will be entitled to wear.

To CARRY OIL THROUGH RIFLED PIPE.—Contracts have been let by the Southern Pacific Company for the building of an oil pipe line 250 miles long from its oil properties in Kern County to a point near Port Costa on San Francisco Bay. The pipe will be rifled on the same principle as a gun barrel, the idea being that the swirling motion given to the oil will make pumping easier. Experiments have demonstrated that the rifled pipe will carry a stream of 20,000 barrels of fuel oil every twenty-four hours, and make it possible to locate the pumping stations about 25 miles apart, a much greater distance than possible heretofore. The rifled pipe is the invention of two Southern Pacific engineers.

ALL-STEEL BOX CARS.—The Union Pacific Railroad has just ordered 25 all-steel box cars, similar to the experimental car described on page 129 of our April issue, to be constructed immediately. With a capacity of 50 cubic feet more than that of the standard Union Pacific wooden box car, the steel car weighs two tons less—37,800 pounds. Actual tests have shown that the one-eighth inch sheet steel forming the sides and ends of the car is stronger than the wood ordinarily used.

FIRST ANNUAL DINNER OF THE OSWEGO APPRENTICES.



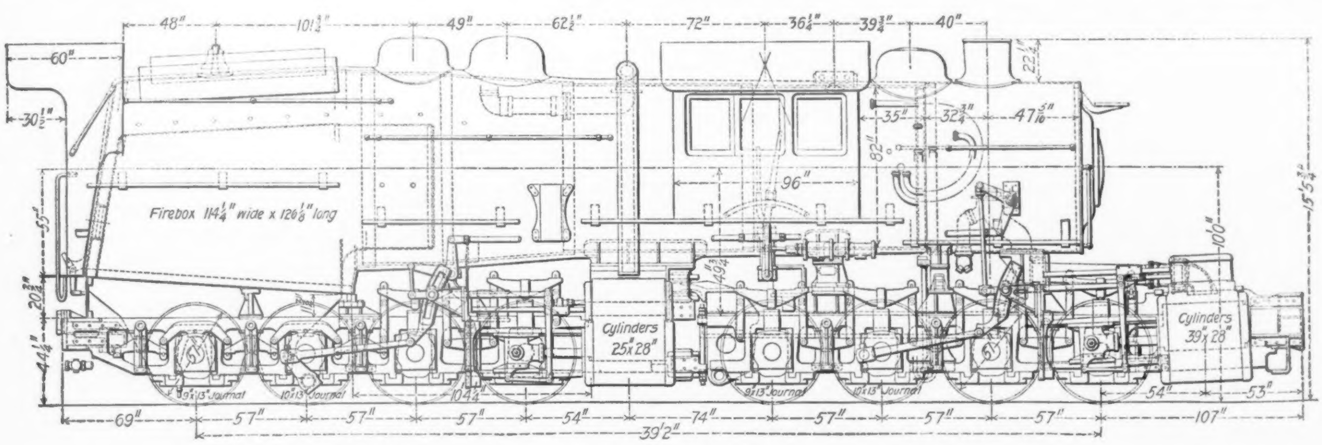
LARGEST LOCOMOTIVE IN THE WORLD—ERIE RAILROAD.

MALLET ARTICULATED COMPOUND LOCOMOTIVE, 0-8-8-0 TYPE.

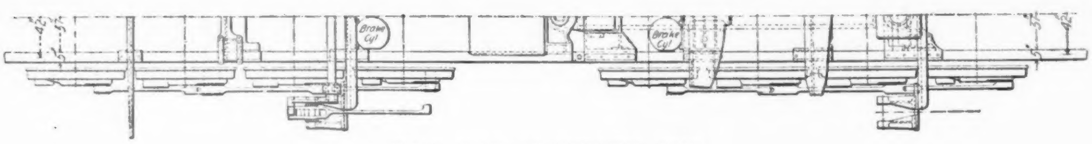
ERIE RAILROAD.

All records of weight, size and power of locomotives have been broken by the completion at the Schenectady Works, of the American Locomotive Company, of the first of an order of three pushing lcomotives for the Erie Railroad. These locomotives weigh 409,000 lbs., all of which comes on the eight pairs of drivers. They have a boiler measuring 84 ins. outside diameter at the front end, containing 21 ft. tubes and a 4 ft. combustion chamber and a firebox with 100 sq. ft. of grate surface, in which soft coal will be burned. The tractive effort operating as a compound is 94,800 lbs. The locomotive and tender measure nearly 85 ft. in length, over all. It is nearly 15½ ft. in height and has a width of 11 ft. at the low pressure cylinders.

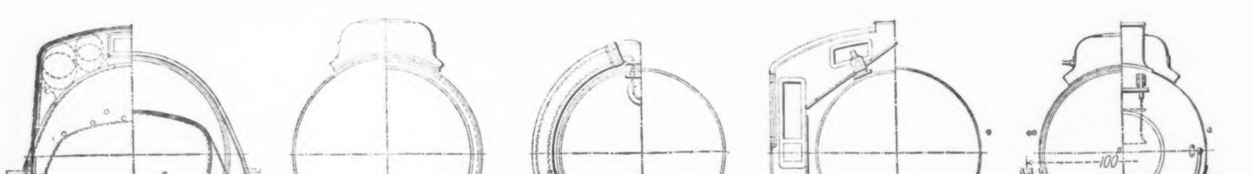
The first locomotive of this type to be built in this country was constructed a little over three years ago by the same company for the Baltimore & Ohio Railroad. At that time the design was looked upon with considerable suspicion by many railroad men. However, after being exhibited at the St. Louis Exposition the locomotive was put into pushing service on the mountains and within a comparatively short time proved to be a complete success in every respect. The present locomotive, while exceeding the Baltimore & Ohio engine by 65,000 lbs. in weight and nearly 24,000 lbs. in tractive effort, is of practically the same design in all of its essential details. Two other designs of the same type have been brought out in this country, both being for the Great Northern Railroad, one designed for pushing service and the other for regular road service. They were built by the Baldwin Locomotive Works. These engines, however, differ from the two designs just mentioned in having two-wheeled trucks, front and rear, making them of the 2-6-6-2 type. While they have been in service a comparatively short time the evidence is sufficient to show that they will be successful



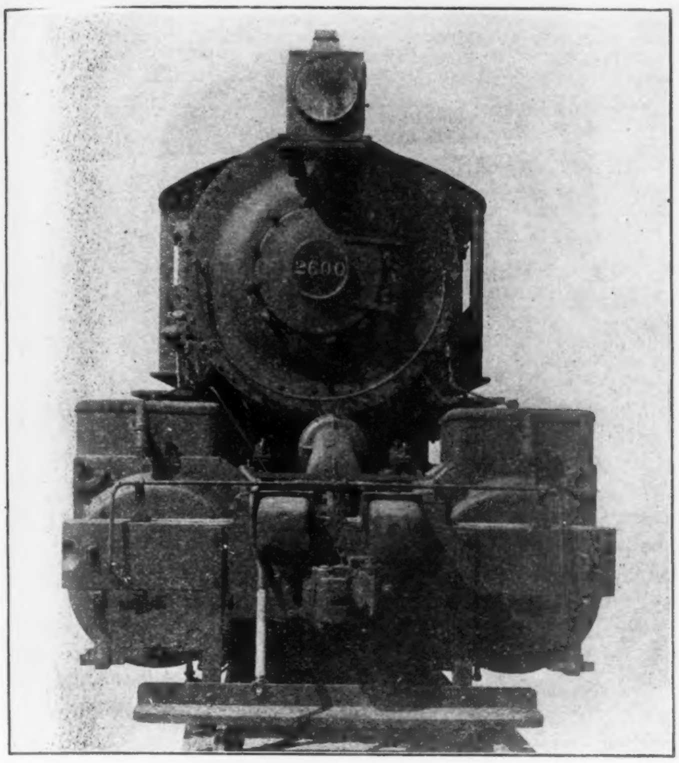
SIDE ELEVATION.



HALF PLAN OF RUNNING GEAR.



CROSS SECTIONS OF ERIE MALLET COMPOUND LOCOMOTIVE.



FRONT VIEW—ERIE MALLET COMPOUND.

for the service intended. Hence, while the Erie engine is of a weight and size which a short time ago would have been considered practically impossible for a locomotive, it cannot really be looked upon as experimental, and all indications are favorable to its successful operation. They will be used in pushing service between Susquehanna and Gulf Summit, where the ruling grade is 1.3 per cent. A tractive effort of nearly 95,000 lbs. should be capable of handling about 2,600 tons, exclusive of the locomotive, on this grade.

The Mallet articulated compound type of locomotive has been described several times in this journal and reference can be made to previous articles, as shown in the accompanying table, for such descriptions. The term, Mallet compound, applies only to the arrangement of the cylinders and driving wheels with separate sets of frames connected through a hinged joint, and does not include any particular design of compounding as concerns the distribution of steam. The Erie locomotives and also the one on the Baltimore & Ohio, are compounded on the Mellin system,* which employs an automatic intercepting and reducing valve for admitting live steam at a reduced pressure to the low pressure cylinders in starting, and for increasing the pressure in those cylinders at any other desired time. The locomotives on the Great Northern Railway are designed with a plain system of cross-compounding without intercepting valves or other automatic arrangements, having, however, a small pipe connection from the boiler to the receiver pipe, by means of which live steam can be admitted at the discretion of the engineer.

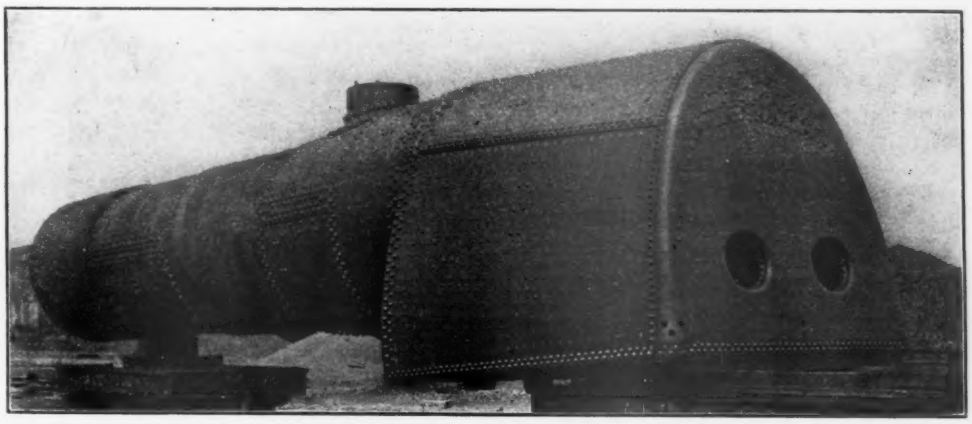
The accompanying table will permit a comparison to be made between the four designs in use in this country. In considering the ratios shown in this table it must be remembered that the boiler of the Erie engine is fitted with a 4 ft. combustion chamber, which considerably reduces the amount of total heating surface in comparison with its size and grate area. The indications from the service already given by combustion chamber locomotives are that the efficiency and the power of the boiler are not reduced by this installation, and hence the ratios of but 53 sq. ft. of heating surface per sq. ft. of grate area, and of but 222 per cu. ft. of cylinder volume do not really indicate that the boiler is not of sufficient size as compared with those of the other designs.

In spite of the fact that this locomotive weighs 409,000 lbs. it has a weight per driving axle which is less than many large freight locomotives now in service and less than any previous Mallet compound locomotive, except the ones for road service on the Great Northern Railway. One of the features of greatest advantage of the Mallet type is that an enormous amount of power can be centered in one machine which will be capable of operating over the same track that other heavy freight locomotives use.

The construction of the boiler is clearly shown in the illustrations, and it is easily seen to be an enormous source of power.

Owner	Erie	G. N.	B. & O.	G. N.
Type	0-8-8-0	2-6-6-2	0-6-6-0	2-6-6-2
Builder	Amer.	Bald.	Amer.	Bald.
Total weight, lbs	409,000	355,000	334,500	288,000
Weight on drivers, lbs	409,000	316,000	334,500	250,000
Tractive effort, lbs	94,800	71,600	70,000	57,760
Diameter cylinders	25″ & 39″	21½″ & 33″	20″ & 32″	20″ & 31″
Stroke	28″	32″	32″	30″
Diameter Boiler	84″	84″	84″	72″
Steam pressure, lbs	215	215	235	210
Diameter drivers	51″	55″	56″	55″
Total heating surface, sq. ft	5313.7	5703.	5600.	3906.
Total weight÷total H. S.	76.9	62.	59.5	73.8
Total H. S.÷vol. cylinders	222.	275.	295.	229.
Total H. S.÷grate area	53.	73.	77.3	73.
B. D. factor	910.	690.	700.	813.
Reference in THE AMERICAN ENGINEER	This issue.	1906. p. 371	1904-p. 237-262	1907 p. 213

It is of the radial stay type with conical connection sheet, the inside diameter of the first ring being 82 in. and that of the largest course being 96 in. The heaviest ring of the shell is 1 3/16 in. thick. A steam pressure of 215 lbs. is carried. The tubes, of which there are 404, are 21 ft. long and are 2¼ inches in diameter. This length of tube, taken in connection with the 4 ft. combustion chamber, places the front tube sheet 25 ft. from the firebox, a figure which has never before been equaled in locomotive service. The combustion chamber itself is radially stayed from the shell of the boiler, and is provided with ample water space on all sides. The mud ring is 5 in. in width at all points, and the crown sheet has a slope of 5 in. from its connec-

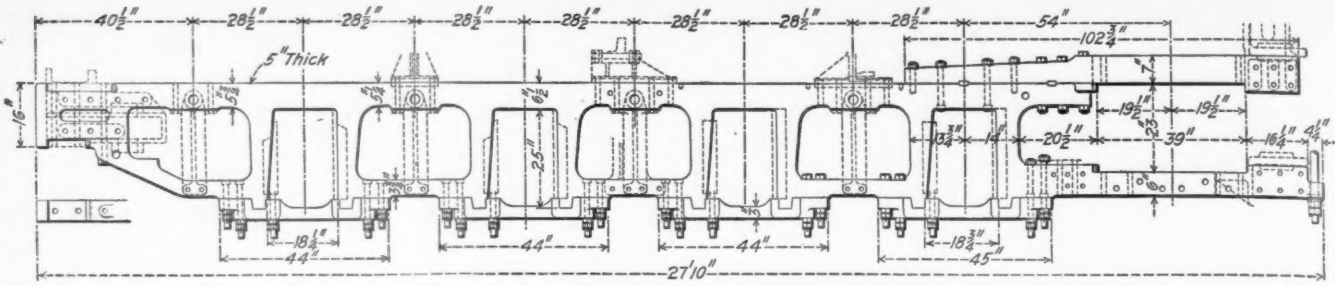


BOILER OF ERIE MALLET COMPOUND LOCOMOTIVE.

tion to the combustion chamber to the door sheet. The dome is placed about central in the length of the boiler, since the locomotive is to operate in either direction and on heavy grades.

A novel design of throttle valve has been fitted to these locomotives, which in addition to taking steam at the top only, also acts as a steam separator. This construction is shown in one of the illustrations, and the arrangement is such that the entering steam strikes against the curved surface of the upper bell upon which the entrained water will be deposited, and following the surface of this casting will pass down through the center of the valve to an outlet below. The top of the bell casting does not take a bearing, and hence it does not in any way act as a

* For description of this system see AMERICAN ENGINEER AND RAILROAD JOURNAL, April, 1906, p. 130.



REAR FRAME—ERIE MALLET COMPOUND LOCOMOTIVE.

valve. The steam is led from the throttle pipe through a short dry pipe to a point directly above the high pressure cylinder, where it passes through the shell to a T head on top of the boiler, and thence through wrought-iron steam pipes on either side to the top of the high pressure steam chest.

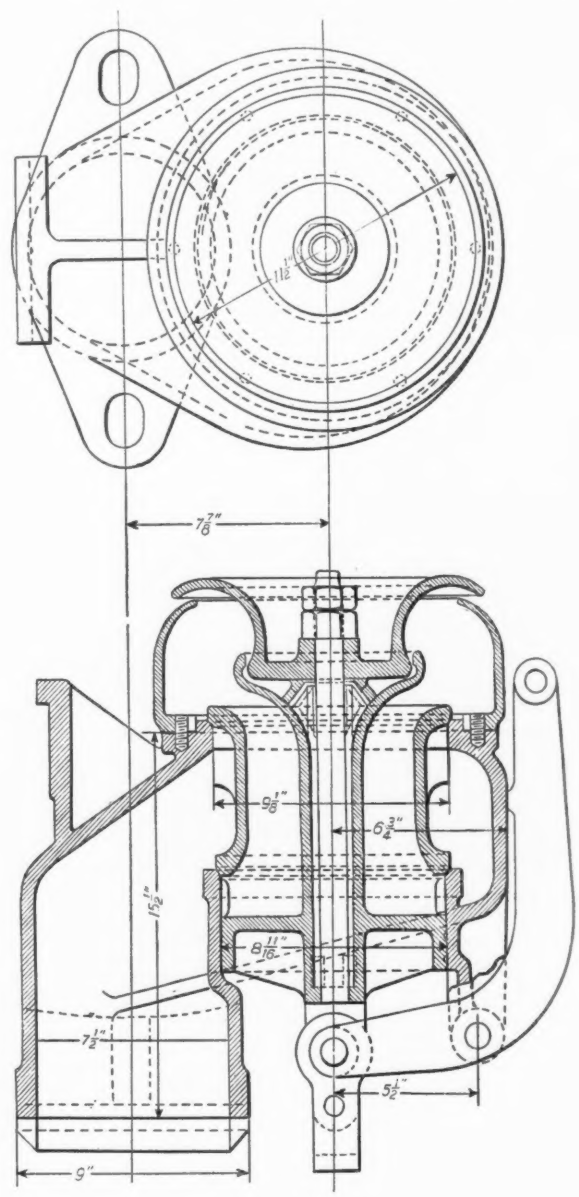
Owing to the extreme width of the firebox it was necessary to place the cab over the boiler shell near the front, and hence all the controlling apparatus, injectors, etc., are located on the right hand side. The injectors feed through a double check valve located on the center line of the boiler, but a short distance back of the front tube sheet.

The high pressure cylinders are very similar to those used on the Baltimore & Ohio locomotive. They are cast in pairs with saddles, the separation between the two cylinders, however, being 8½ in. to the right of the center. This permits the intercepting valve to be placed in the left-hand cylinder casting and also gives room for the connection to the receiver pipe. The exhaust steam from the right cylinder continues from the passage in its saddle to an outside U-shaped pipe connecting to a passage in the left-hand cylinder casting which leads up to the intercepting valve chamber into which the exhaust steam from the left cylinder also passes. From this point the exhaust steam passes to a 9 in. receiver pipe extending forward between the frames to the low pressure cylinders. An extra exhaust connection is provided in the side of the left cylinder casting, which has a 4½ in. pipe leading to the exhaust pipe in the smokebox. This connection is made by a pipe having universal joints in a manner similar to the receiver pipe. The construction of the receiver pipe is such as to permit free movement of the front frames in all directions, it being fitted with a ball joint at either end and a slip joint near the forward end. It is arranged to permit the locomotive to pass around 16-degree curves. The low pressure cylinders are cast in pairs, the connection to the receiver pipe being made through a Y-shaped casting connecting at the back to the cored passages in the cylinder. The exhaust is carried through an elbow located on top, and in the center, to a short pipe with universal joints leading to the exhaust pipe in the front end.

The high pressure cylinders are fitted with piston valves having internal admission while the low pressure cylinders have balanced slide valves with external admission. The valve gear, which is of the Walschaert type, is so arranged that the return crank leads the pin in both sets, and hence the block is at the bottom of the link for the go-ahead motion for the low pressure cylinders and at the top of the link for the high pressure cylinders. In this way the weights of the two valve gears counterbalance each other. The operation of reversing is further assisted by a pneumatic reversing device, which is connected to the reverse lever and consists of two cylinders, one of which contains oil under pressure for locking the device in any desired position, the other cylinder being the air cylinder. The operation of this device is controlled from an auxiliary reversing lever in the cab.

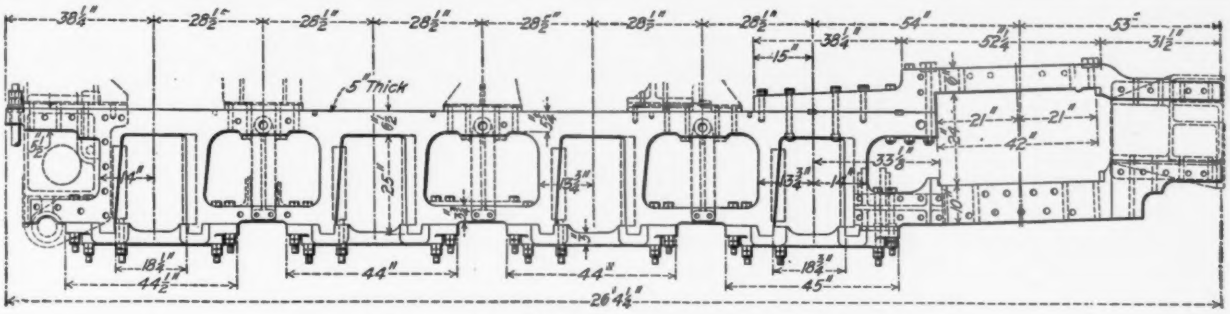
The construction of the cast-steel frames is shown in one of the illustrations and needs no explanation. Special care has been given to obtaining a thorough system of cross bracing. The articulated connection between the two groups is made in practically the same manner as was used on the Baltimore & Ohio locomotive, the hinge joint being formed in castings secured ahead of the high pressure cylinder. The vertical bolts connecting the upper rail of the front group with the lower rail of the rear group are fitted with ball joints to permit free movement of the two frames relative to each other, and are provided for holding the frames in line and preventing binding on the hinged connection.

The weight of the boiler extending beyond the high pressure cylinder saddle is transferred to the front set of frames at two points, which are normally in contact, and two other points, which will come into contact under unusual conditions. The one



THROTTLE VALVE.

which carries the largest amount of weight has a self-adjusting sliding bearing, and is located between the third and fourth pair of drivers. This bearing will permit free movement in all directions in the horizontal plane, and also includes a safety connection which prevents the frames from dropping away from the boiler in case of any derailment. There is also a similar safety connection provided at the front end of the boiler between the guide yoke casting and the exhaust pipe elbow. The other support between the boiler and frames is located between the second

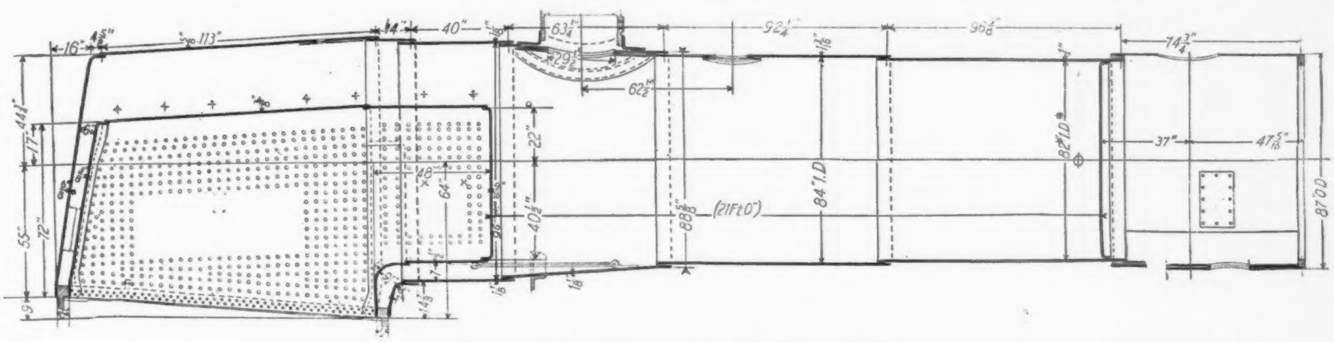


FRONT FRAME—ERIE MALLET COMPOUND LOCOMOTIVE.

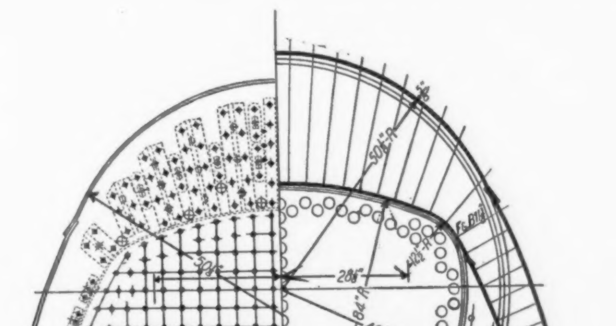
and third pair of drivers and consists of two vertical columns located just inside the frames and fitted with ball joints at either end. The upper end takes a seat in projections on the casting fastened to the boiler and the lower end seats in castings having one end hinged below a frame cross tie across the lower rails. These hinged castings are held in place by U-bolts at the opposite end, which pass up through the cross tie and are supported on coiled springs. In this manner a flexible connection is formed by the use of comparatively light springs and this support will take a varying load corresponding to the location of the frames with reference to the boiler. The initial compression of these springs is 30,000 lbs., and can be varied as found desirable.

A spring centering device is located between the second and third pair of drivers just ahead of the column support mentioned, and is provided with coiled springs for bringing the front group into line after leaving a curve. This construction also includes an emergency bearing which is normally separated about ½ in.

The front group of driving wheels are equalized together on each side and cross equalized in front of the forward drivers, thus making this system equivalent to a single supporting point. Each side of the rear engine is equalized independently. The locomotive is fitted with two New York duplex No. 5 air pumps and carries four air reservoirs located on top of the firebox and arranged as shown in the illustration. The general dimensions, weights and ratios are as follows:



LONGITUDINAL SECTION THROUGH THE BOILER.



PART REAR VIEW AND CROSS SECTION THROUGH FIREBOX.

GENERAL DATA.

Gauge	4 ft. 8½ in.
Service	Pushing
Fuel	Bit. Coal
Tractive effort, compound	94,800 lbs.
Weight in working order	409,000 lbs.
Weight on drivers	409,000 lbs.
Weight of engine and tender in working order	572,000 lbs.
Wheel base, driving	39 ft. 2 in.
Wheel base, total	39 ft. 2 in.
Wheel base, engine and tender	70 ft. 5½ in.

RATIOS.

Weight on drivers ÷ tractive effort	4.32
Total weight ÷ tractive effort	4.32
Tractive effort × diam. drivers ÷ heating surface	910.00
Total heating surface ÷ grate area	53.14
Firebox heating surface ÷ total heating surface, per cent	6.46
Weight on drivers ÷ total heating surface	76.90
Volume both cylinders, cu. ft	24.00
Total heating surface ÷ vol. cylinders	222.00
Grate area ÷ vol. cylinders	4.17

CYLINDERS.

Kind	Mellin compound
Number	4
Diameter	25 and 39 in.
Stroke	28 in.

VALVES.

Kind, H. P.	Piston
Kind, L. P.	Richardson Bal. Slide
Greatest travel	5½ in.
Outside lap, H. P.	1⅛ in.
Outside lap, L. P.	1 in.
Inside clearance	¼ in.
Lead in full gear	3/16 in

WHEELS.

Driving, diameter over tires	51 in.
Driving, thickness of tires	3½ in.
Driving journals, main, diameter and length	10 × 13 in.
Driving journals, others, diameter and length	9 × 13 in.

BOILER.

Style	Straight, with Conical Connection
Working pressure	215 lbs.
Outside diameter of first ring	84 in.
Firebox, length and width	126⅛ × 114¼ in.
Firebox, plates, thickness	⅜ and ½ in.
Firebox, water space	5 in.
Tubes, number and outside diameter	404—2¼ in.
Tubes, length	21 ft.
Heating surface, tubes	4,971.5 sq. ft.
Heating surface, firebox	343.2 sq. ft.
Heating surface, total	5,313.7 sq. ft.
Grate area	100 sq. ft.
Smokestack, diameter	18 in.
Smokestack, height above rail	15 ft. 5¾ in.
Center of boiler above rail	120 in.

TENDER.

Tank	Water Bottom
Frame	12 in. 40 lb. Channels
Wheels, diameter	33 in.
Journals, diameter and length	5½ × 10 in.
Water capacity	8,500 gals.
Coal capacity	16 tons

SOME IMPORTANT RESULTS FROM THE PENNSYLVANIA RAILROAD TESTING PLANT AT ST. LOUIS.

Locomotive.	Speed. miles per hour.	Rev. per min.	Cut off per cent. of stroke.	Steam pressure. Lbs.	Ind. horse power.	Dynamometer horse power	Dynamometer pull. Lbs.	Total moist coal per hr.	Total dry coal per hr. Lbs.	Dry coal per sq. ft. grate area per hour.	Total water evap. per hr. Lbs.	Total dry steam per hr. Lbs.	Dry Steam per sq. ft. H. S. Lbs.	Dry steam per lb. of dry coal. Lbs.	Lbs. steam per I. H. P.	Lbs. steam per D. H. P.	Temp. of fire-box.	Temp. of smoke-box	Draft front of diaphragm.*	Effic. of boiler	Machine effic. loco.	Heat effic. loco.
FREIGHT LOCOMOTIVES.																						
No. 1499.	6.7	40.4	30.45	203.4	454.	373.5	20,864	1383.	1368.	27.8	12 915	12,823	5.17	9.373	27.29	33.21	1,480	581	....	77.45	82.18	5.13
2-8-0 Type.	13.4	80.7	39.34	201.4	930.	789.2	22.078	3489.	3448.	70.07	23,656	23,454	9.45	6.802	24.7	29.12	1,766	685	3.6	53.15	84.82	4.01
P. R. R.	20.	120.6	33.96	193.1	1036.	848.6	15,883	4083.	4041.	82.11	25,192	24,982	10.06	6.83	23.74	28.98	2,001	724	4.66	50.59	81.91	3.84
	26.7	160.9	32.91	185.9	1050.	774.2	10,863	4672.	4627.	94.04	26,007	25,722	10.36	5.558	24.15	32 76	2,110	715	3.91	45.47	73.71	2.95
No 734.	7.52	40.11	41.27	199.6	550.4	491.8	24,522	2049.4	2027.	60.03	15,713	15,549	6.119	7.674	27.31	30.57	1,992	551	3.06	58.57	89.35	4.23
2-8-0 Type.	14.99	80.	40.69	204.	962.5	894.6	22,371	4199.7	4152.	122.97	24.836	24,544	9.658	5.912	24.93	26.82	2,152	650	5.85	46.28	92.94	3.79
L. S. & M. S.	22.28	118.9	35.70	189.4	1098.2	957.3	16,104	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6.40	.....	87.17	.....
	30.04	160.32	27.37	199.4	1053.9	896.8	11,188	4726.3	4695.	139.04	25,882	25,610	10.077	5.455	23.92	28.12	2,162	667	5.91	41.81	85.09	3.27
No. 585.	7.49	40.01	48.6	210.1	512.	481.6	24,105	1084.	1073.	21.70	10,926	10,801	3.832	10.069	20.27	21.55	1,445	508	.88	78.42	94.06	8.04
2-8-0-C Type.	14.98	79.98	57.5	210.9	1040.7	980.	24,539	2584.	2559.	51.77	21,545	21,300	7.556	8.324	20.03	21.27	1,332	592	3.19	64.18	94.16	6.64
M. C.	29.96	159.97	64.3	175.1	1001.3	859.7	10,762	3905.	3876.	78.41	25,030	24,801	8.798	6.399	24.43	28.45	1,620	638	5.02	49.81	85.86	3.86
No. 929.	6.714	39.97	40.8	213.5	633.6	557.3	31,131	1764.	1751.	29.98	15,376	15,204	3.531	8.682	23.38	26.58	1,642	486	.91	66.82	87.95	5.51
2-10-2-C Type	13.652	81.283	51.4	213.5	1257.9	1136.2	31,240	4343.	4299.	73.61	31,877	30,603	7.107	7.119	24.04	26.60	1,932	574	3.68	54.69	90.48	4.51
A. T. & S. F.	10.184	60.639	41.9	216.7	888.8	787.6	29,005	2401.	2381.	40.77	20,034	19,808	4.6	8.319	21.84	24.65	1,737	497	1.63	63.55	88.61	5.65
PASSENGER LOCOMOTIVES—FOUR-CYLINDER BALANCED COMPOUND.																						
No. 2512.	19.14	80.	39.7	215.2	495.7	439.7	8,615	1013.1	1005.	30.09	9.742	9,634	3.627	9.589	18.6	20.96	1,737	507	.92	74.88	88.71	7.83
4-4-2 Type.	38.26	160.	49.7	206.4	994.6	842.9	8.262	3067.3	3038.	91.	20,184	19,977	7.521	6.575	20.67	23.16	1,818	591	3.53	51.35	89.23	4.86
DeGlehn.	57.39	240.	34.2	217.5	802.3	653.1	4,268	2665.5	2641.	79.09	18,241	18,003	6.778	6.818	21.62	26.56	....	586	3.56	55.99	81.41	4.53
P. R. R.	66.96	280.	29.2	215.	682.5	510.1	2,857	2925.	2897.	86.77	19,373	19,115	7.196	6.598	27.05	36.19	2,044	581	3.27	51.48	74 74	3.06
No. 535.	18.79	80.	53.	220.4	808.4	642.3	12,815	2077.	2058.	42.56	17,279	17,047	5.874	8.28	20.56	25.88	1,882	560	2.62	64.5	79.46	5.41
4-4-2 Type	37.55	160.	50.5	221.	1296.1	1114.4	11,119	3293.	3258.	67.36	25,924	25,585	8.816	7.86	19.41	22.58	1,975	625	4.54	62.48	85.99	6.04
Bald. comp.	56.38	240.	51.3	221.9	1621.5	1269.8	8,444	5753.5	5701.	117.87	34,126	33,630	11.589	5.9	20.48	26.15	2,162	689	6.59	46.05	78.51	3.81
A. T. & S. F.	65.77	280.	47.7	219.5	1459.7	898.	5,120	5162.7	5104.	105.52	31,102	30,681	10.572	6.01	20.73	33.7	2,177	660	5.58	47.27	61.53	3.03
No. 628.	18.57	80.	44.9	202.	480.5	446.4	9.016	1217.7	1206.	41.51	9,176	9,176	5.234	7.607	17.82	19.18	2,108	597	1.29	63.3	92 91	6.65
4-4-2 Type	37.13	160.	47.8	198.8	813.7	754.5	7,622	2704.6	2679.	92.18	15,193	15,193	8.667	5.673	17.86	19.26	2,253	707	2.94	47.33	92.76	4.97
Hanover.	55.7	240.	46.4	187.	816.4	644.4	4.339	3559.6	3523.	121.3	15,804	15,804	9.015	4.485	18.8	23.81	2,048	787	3.7	39.55	78.94	3.32
Loco. Works	65.05	280.27	35.8	204.2	688.4	593.7	3,422	2558.	2525.	86 88	15,244	15,244	8.697	6.039	21.29	24.69	2,043	676	3.5	50.73	86.24	4.14
No. 3000	18.76	80.	45.9	210.8	714.4	606.5	12,121	1766.	1749.	35.05	15,494	15,313	5.104	8.756	20.47	24.11	1,938	536	1.95	69.	84 89	6.18
4-4-2 Type	37.52	160.	57.1	221.4	1490.5	1278.8	12,780	4932.	4880.	97.79	33,754	32,561	10.853	6.673	21.57	25.14	2,111	672	6.29	53.05	85.8	4.55
Cole comp.	56.29	240.	53.7	212.3	1641.4	1475.6	9,831	6768.7	6694.	134 15	41.120	40,034	13.343	5.98	24.14	26.86	2,339	743	8.86	46.89	89.9	4.01
N. Y. C. & H	65.66	280.	38.2	220.2	1368.9	1188.5	6.788	3929.	3889.	77.94	31,561	30,791	10.263	7.918	22.19	25.55	2,259	675	6.51	62.11	86.83	5.23
	75.05	320.	41.	222.3	1335.7	1045.4	5,224	4976.	4928.	98.76	32,906	31,818	10.604	6.456	23.51	30.04	2,174	678	6.68	51.02	78.27	3.42

*Inches of water

Locomotive number	1499	734	585	929	2512	535	628	3000
Total weight, lbs	194,200	181,300	189,000	285,740	164,000	201,500	133,350	200,000
Weight on drivers, lbs	173,200	162,600	164,500	233,760	87,850	99,200	65,350	110,000
Tractive effort, lbs. (M. E. P.-80% B. P.)	39,773	33.616	31,838	63,612	16,700	19.245	13,789	20,590
Diameter of drivers, in	56	63	63	56½	80	79	78	79
Diameter of cylinders, in	22	21	23 & 35	19 & 32	14.2 & 23.7	15 & 25	14,16 & 22	15½ & 26
Stroke of cylinders, in	28	30	32	32	25¼	26	23⅝	26
Steam pressure, lbs	205	200	210	225	225	220	200	220
Diameter of boiler, in	71	68⅜	70⅛	81.	60.	69	62¼	72¼
Number and diameter of flues	373-2	338-2	363-2	393-2¼	139-2¾	273-2¼	241-2	390-2
Length of flues, ft. and in	13-8½	14-10⅞	15-10⅜	19-10½	14-8⅛	18-9⅛	12**	15-11¼
Flue heating surface, sq. ft. †	2677.27	2638.97	3015.34	4601.	1468.87	3016.71	1511.94	3255.27
Total heating surface, sq. ft. †	2843.67	2857.89	3181.03	4817.36	1646.15	3237.01	1932.16††	3406.96
Grate area, sq. ft	49.2	33.76	49.42	58.41	33.39	48.36	29.06	49.9
Firebox H. S.÷total H. S. per cent	5.9	7.7	5.2	4.5	10.8	6.8	5.5	4.45
Total H. S.÷grate area	58	84.7	64.4	82.5	49.4	67	66.5	68.3
Tractive eff. × diam. driv.÷total H. S.	783	742	630	745	810	470	558	478

†—Water side of tubes, calculations are based on area of fire side tubes. **—Not including 2 ft. 6 in. in Pielock superheater.
††—Includes superheating surface.

The above table is one which has been compiled for use in the office of this Journal and has proved to be so handy for ready reference that it is believed our friends will find it of convenience and value.

It contains the results obtained from the locomotives, tested on the testing plant of the Pennsylvania Railroad at the St. Louis World's Fair which are most often desired for reference, either for comparison with other tests or as a basis of design. The results included in the table are those from the tests which gave the highest indicated horse-power at each speed tested for each locomotive. It should be remembered that this is by no means the most economical point of operation and that these results simply show what the locomotives were capable of doing under the conditions imposed and do not necessarily indicate what it would be desired that they should do for economy of coal, water or repairs. Reference should be made to the complete figures of all the tests published by the Pennsylvania Railroad Company for information on that and many other similar points.

CO-OPERATION BETWEEN THE OPERATING AND MECHANICAL DEPARTMENTS.

(Suggestions for Decreasing the Cost of Locomotive Repairs.)

BY A. W. WHEATLEY.

Many operating men would be surprised if they were to examine the annual statements of their roads and note the large amount of money expended in the maintenance of locomotives. Ordinarily they consider this a matter of minor interest and apparently overlook the effect of it on the cost of conducting transportation.

Considering the general usage of locomotives on the road: Apparently very little attention is given to the movement of the average freight train over a railroad. On a single track road doing a heavy business many cases of poor dispatching occur. The dispatchers are worked to their limit, and they are not infallible. Do they receive the same supervision in checking as the other departments do? The engineers make daily reports showing all delays and copies of these reports are sent to the superintendent and master mechanics, but are they examined with a view of improving conditions? These men are very busy and undoubtedly cannot look over all of these reports carefully. Would it not be better if only the worst reports were submitted to them, those, for instance, where trains exceed a certain time in going over a division? These daily reports are very important and represent the pulse of the railroad.

For comparative purposes reports should be prepared monthly, showing by divisions the total number of engine hours, the total available engine hours, the total actual engine hours, and the average speed per actual engine hour. Such a report would show exactly what is being done and would be valuable in many ways.

The chief train dispatcher can do a great deal toward reducing the cost of repairs by co-operating with the local mechanical officials. Systematic assistance from the dispatcher as to the probable engine requirements for a given period in advance will be of material benefit. Roundhouse foremen frequently know of work that should be done on a locomotive, but are unable to do it because of inability to secure reliable information as to when the engine will be wanted. The foreman is compelled to protect himself, as he is usually severely criticized if unable to furnish power when needed. It is not at all uncommon for locomotives to remain from six to ten hours in the roundhouse without having any work done on them, not because repairs are not necessary, but because the roundhouse foreman did not know when the engines would be called for. The old saying that "a stitch in time saves nine" has an important application to a locomotive; cylinder packing examined today will frequently prevent a failure tomorrow. Reports can and should be furnished to roundhouses at 9 A. M. and 6 P. M. for power that will be required during the ensuing ten hours.

Power is seriously affected by the improper handling at the terminals and many failures can be attributed to this cause. Master mechanics should give their personal attention to this matter. Hostlers permitting power to remain out of doors longer than necessary or abusing locomotives on the cinder pit by the improper use of blowers should be disciplined. Roundhouses should be designed to permit of the locomotives having the fire cleaned inside, instead of out of doors, thus permitting of their being housed promptly on arrival at the terminal. Suitable ventilation and conveyors should be provided and with such an arrangement the delay of locomotives at terminals could be materially reduced.

Ordinarily the roundhouse foreman pays very little attention to the cost of repairs. Some means should be provided by which he may be made familiar with these costs. The locomotives should be operated with an allowance for repairs, statements should be furnished showing the financial condition of each engine every two months; these reports should be posted in a conspicuous place in the roundhouse, so that the engineers may also become interested. The average engineer and mechanic is ignorant of the cost of power and maintenance and some means must be taken to place the figures before them and to set them thinking; at the same time it will show that the officers are interested in this matter and that it is one of importance. The system suggested above will encourage the roundhouse foreman to improve the efficiency of his organization.

The foreman should be allowed sufficient help to keep the power clean. Many roads have practically discontinued the cleaning of locomotives, but this would appear to be a serious mistake. Nothing is more demoralizing than dirty power. It tends to destroy the personal pride of all concerned. Put an engineer or a mechanic on a dirty locomotive and nine times out of ten you will get poor work in return.

The shopping of locomotives at the proper time is an important matter. Care should be taken that locomotives are not shopped until there is a vacancy in sight. With a road doing a reasonably even business, this is not a difficult matter. In this connection the writer feels that engines should be required to make certain fixed mileage between shoppings for general or heavy repairs. This will prevent the shopping of engines for expensive repairs when light roundhouse repairs are all that is necessary. Considerable money is wasted in this manner, especially at a time of transferring power from one division to another. The receiving master mechanic and superintendent, get together and scrutinize the power just received, and for some unexplained reason it is never as good as the power they have parted with, and they decide to shop it and put it in first-class condition, smiling with an assurance that the other fellow must pay for it.

Shop organization has received a great deal of attention recently, and it can be said without fear of contradiction that on many roads the railroad shop is the best supervised and the most economically managed department. The most important feature in the operation of a shop is that of cost and an allowance plan can be used to marked advantage. Job prices should be fixed; also a total repair price, and these costs should not be exceeded except for good reasons. In all branches of the work we should endeavor to give the man a mark to reach, one that can be reached at times by special effort, so that he will not become discouraged and consider it impossible to reach.

Very little can be accomplished without co-operation and harmony between the different departments. Unfortunately the average railroad man has very little regard for departments other than the one with which he is connected. The superintendent, if his title is correct, should be held absolutely responsible for every cent of expense in his territory. *The title of master mechanic should be replaced by that of assistant superintendent; this will have a tendency to broaden mechanical men and place them in line for higher positions.* Division superintendents should report to the superintendent of motive power on mechanical matters. With such an organization the different departments will be brought closer together and all concerned will become broader and better men. The railroads today are suffering from the lack of such men and its effect on the cost of locomotive repairs cannot be overestimated. The subject is a very serious one, and deserving of equal attention by both mechanical and operating officials.

INCREASING COST OF RAILROAD SUPPLIES.—An idea of the increasing cost of supplies which must be purchased by a railroad is obtained by comparing prices paid by the Pennsylvania Railroad Company last year (1906) with those of the current year. Steel angles have increased in price 31 per cent., bronze journal bearings 25 per cent., copper 22 per cent., freight car wheels 21 per cent., and malleable iron castings 20 per cent. Brass and tin have each increased 16 per cent., car axles and cross ties 12 per cent., rail braces 8 per cent., white pine lumber 8 per cent., and air brake hose 7 per cent.

PROGRESS ON THE PANAMA CANAL.—The Isthmian Canal Commission announces that the excavation on the canal during July was as follows: Culebra division, 770,570 cu. yds.; Gatun, 74,765 cu. yds.; dredging in canal prism, 212,710 cu. yds.; total, 1,058,770 cu. yds., against 780,957 cu. yds. in June. This is the largest month's work yet done. The rainfall for the month is reported at 9.5 in., against 14 in. in June.

FORGING AT THE COLLINWOOD SHOPS.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

(EDITOR'S NOTE: Other articles describing the machine forging work done at the Collinwood shops will be found on page 142 of the April, 1906, issue; page 234, June, 1906; and page 192, May, 1907. Similar work which is being done at the South Louisville shops of the Louisville & Nashville Railroad was described on page 125 of the April, 1907, issue.)

The dies and header for welding the end or cross bar on an ordinary clinker hook are shown in Fig. 1. Both bars are heated to a welding heat and placed in position between the dies; at one stroke of the machine they are welded together and the stock is gathered at the intersection to strengthen it, as shown in the illustration. To guard against the loss of welding heat when the comparatively light bars come in contact with the heavy dies a jet of compressed air * is blown on them. Those of our readers who have tried the experiment of burning a bar of iron by heating and then playing a jet of compressed air upon it will understand this action. After the two bars are welded together the hook is completed by bending it on a device attached to the forging machine.

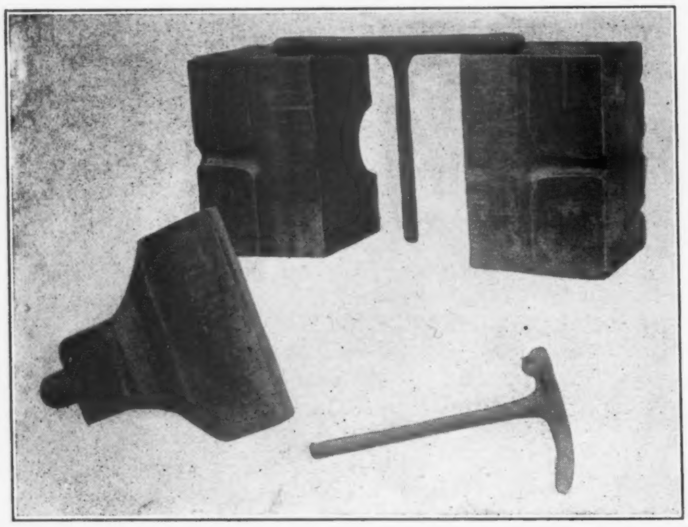


FIG. 1. DIES AND HEADER FOR WELDING END ON CLINKER HOOK.

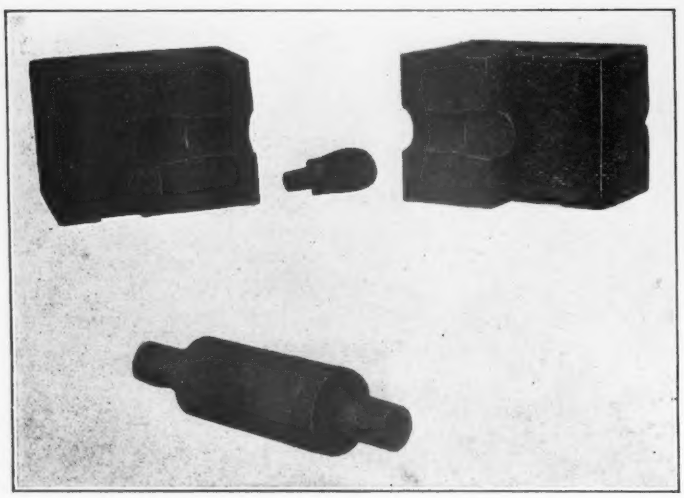


FIG. 2. DIES AND HEADER FOR FORGING SLING STAY I-BOLT.

The dies and headers for making sling stay I-bolts at one operation on a 3½ in. Ajax forging machine are shown in Fig. 2. The end of the bar is first pinched in the dies so that it will enter the hole in the end of the header. The bar is then brought up against a stop which adjusts the length and the dies are closed, shearing off the end and holding the blank in the pocket of the die; the header then comes forward and forms the pin and collar.

The dies and headers shown in Fig. 3 are used for forming and punching brake hangers made of ⅞ in. round iron. Those shown in the upper half of the photo upset the ends and form the boss, and those in the lower half punch the hole through it.

The device shown in Fig. 4 is used in connection with a bull-dozer for bending and shearing a steel ratchet pawl at one stroke of the machine. The blank is first punched out on the forging machine; it is then heated and flattened under a Bradley hammer, after which it is quickly passed to the operator of the bull-dozer, before it has had time to cool, and is pressed to shape and sheared. The two wedges are fastened to the face plate or plunger of the bull-dozer and the rest of the device is clamped to the table. As the plunger of the bull-dozer moves forward the long wedge enters the device and forces the dies together, bending and gripping the pawl; the short wedge on the left then enters and forces the shears forward, cutting off and completing the pawl.

A combination tool for bending drawbar pockets and punching a hole for liners is shown in Fig. 5. After the bar for the pocket has been gibbed and sheared to the proper length on the forging machine it is heated and clamped in the head of the device by means of the lever which operates a cam. When the head moves forward the iron comes in contact with the two rollers and is bent to shape. These rollers may be adjusted for different widths of couplers by placing liners behind the frames in which

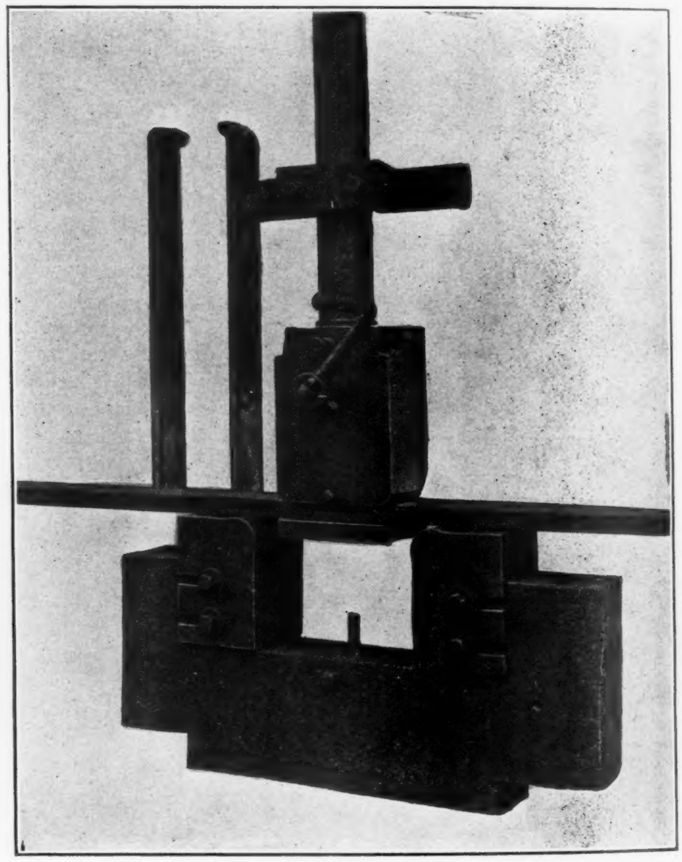


FIG. 5. COMBINATION TOOL FOR BENDING AND PUNCHING DRAWBAR POCKETS.

they are carried. At the same time that the bar is being bent to shape the hole for the liner is punched.

* See following article.

COMPRESSED AIR IN FORGING.*

One of the small kinks in the Collinwood shops that has helped us in successful welding in the forging machine, is a compressed air jet used for bringing two pieces of iron to a point of fusion immediately before the stroke of the forging machine.

While some blacksmiths may be familiar with this method, we find it is new with many others. A very interesting experiment to demonstrate the possibilities with this method is to heat a bar of one inch or one and one-fourth inch iron on the end for five or six inches, then blow a stream of air against the end of the bar parallel with its length; a beautiful display of fire-

* Note connection with previous article.

works will be the result, the temperature of the bar will be raised to a point of fusion and the bar will melt away as in the foundry cupola.

We have been quite successful in making large crank pin nuts with the aid of this method. A piece of bar iron 2 x ⅞ in. is rounded up under the hammer, each end of the bar being sheared to an angle of 45 degrees so as to form a lap. These pieces of iron are heated in an oil furnace, placed between the dies of the forging machine, a jet of air is blown against the two ends, which cleans out all dirt and scale and raises the temperature of the metal to a welding heat, one stroke of the machine insuring a perfect weld with clean metal.

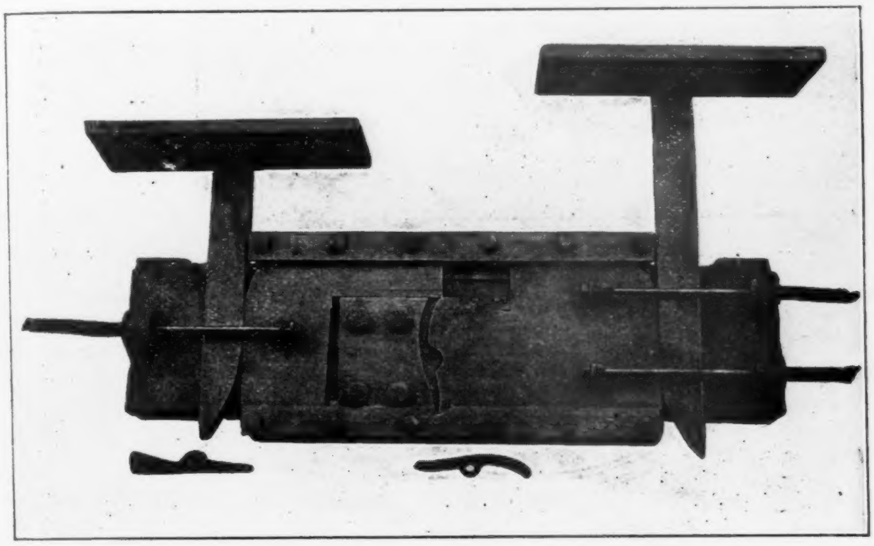


FIG. 4. DEVICE FOR BENDING AND PUNCHING STEEL RATCHET PAWLS.

The same method is used in welding the cross bar on our clinker hooks for locomotive service. The end of the long rod and a short bar are both heated to a welding heat in our oil furnace; the long rod is butted against the short piece and placed between the dies, where it comes in contact with the jet of compressed air, which blows out all scale and dirt, bringing the two pieces to a perfect welding heat and one stroke of the machine completes the weld and upsets the metal so as to strengthen the hook at the point of intersection.

In repairing and welding broken spokes or rims in steel driving wheels, we think the compressed air jet is indispensable. Some of the wheels are very difficult to handle owing to the counterbalance and it is very difficult to get a wheel from the fire to the anvil without losing the heat. By using the compressed air jet it is possible to revive the heat and the parts to be welded will retain a welding heat after the operation is completed. In welding spokes in steel wheels we use the "V" weld. The heat is taken on a side fire and just before the piece is welded into the spoke, the compressed air jet is brought in contact with the hot metal, keeping the temperature of the metal up to a welding heat until the operation is completed. Care must be taken, however, in applying this compressed air jet, as it would be possible to burn a spoke in two if held at one point too long.—*Mr. Geo. A. Hartline, Blacksmith Foreman, L. S. & M. S. Ry., in the Railway Journal.*

LONG ISLAND PASSENGER TRAFFIC.—The average daily passenger traffic on the Long Island Railroad amounts to about 60,000, there being about 40,000 carried per day in winter and 80,000 in summer. On last Decoration Day there were 128,625 passengers carried on this system.

THE SURCHARGE PROBLEM.

The cost of material manufactured on the road, as listed on store house books, is usually low compared with market prices. The value of manufactured material is commonly figured as direct labor cost plus material cost, and I find some roads adding from two to ten per cent. to their labor to cover handling and other direct expenses. These figures are ridiculously low, as manufacturers find that overhead or surcharge expenses are often two and three times the direct labor. It is not important that cost be figured accurately when the material is only passed from one department of a road to another, or from one division to another. It is in this case simply taking from one pocket and putting in another.

It is important that values be known accurately when the question arises of buying or making certain articles. All the cost of rent, supervision, machinery, power, heat, light, etc., enters into the cost of each repaired engine, or engine part, delivered from the locomotive repair shop. Until these items are all prorated over the cost of the shop output no comparative figures as to value are obtained.

These items make up the surcharge problem and are just as real a part of the cost as the material or the labor which we call direct, and locate. Direct labor and unlocated cost each enter into the final value of an article just as much as power to move a balanced compound engine is developed in both the high pressure and low pressure cylinders. The high pressure cylinders may be between the frame and not in evidence to the untrained eye,

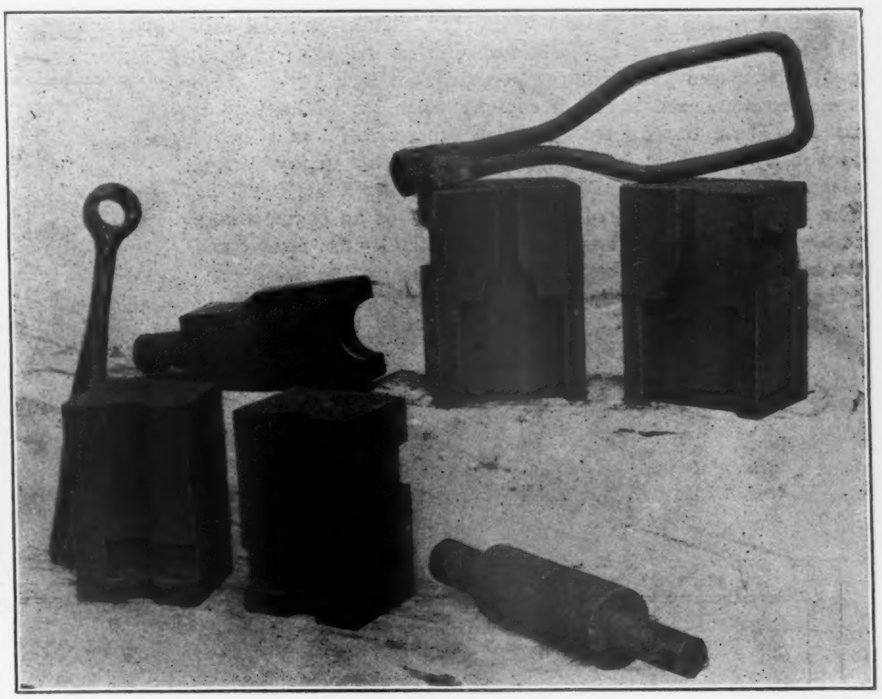
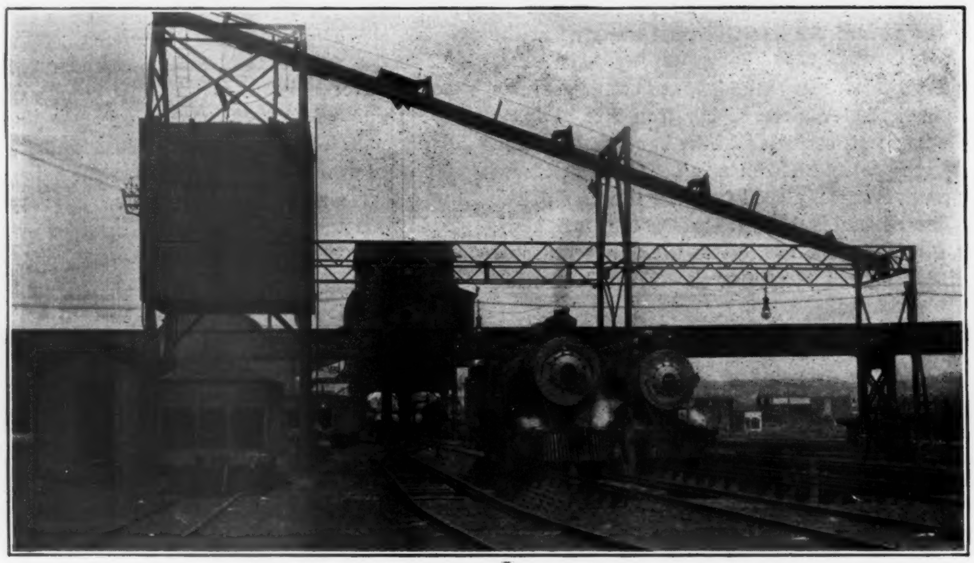


FIG. 3. DIES AND HEADERS FOR FORMING AND PUNCHING END OF BRAKE HANGERS.

but these cylinders must be considered in figuring tractive effort or we underestimate it in about the same proportion as we underestimate costs if we do not include the surcharge, which is no more evident to the untrained mind than the high pressure cylinders of a balanced compound are to a farmer.—*Mr. H. W. Jacobs.—From a paper read before the Railway Storekeepers' Association.*

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.—This association will hold its annual convention at the Ryan Hotel, St. Paul, Minn., on September 10th.



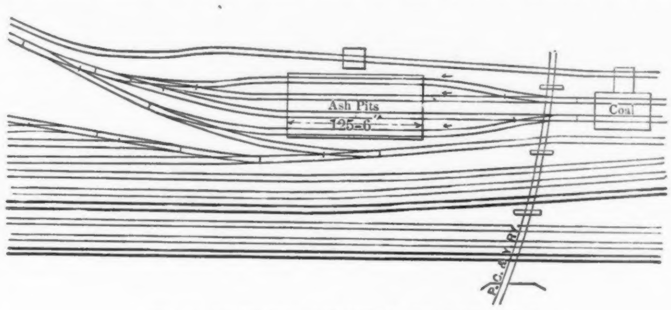
ASH HANDLING PLANT—PITTSBURGH & LAKE ERIE RAILROAD

ASH HANDLING PLANT.

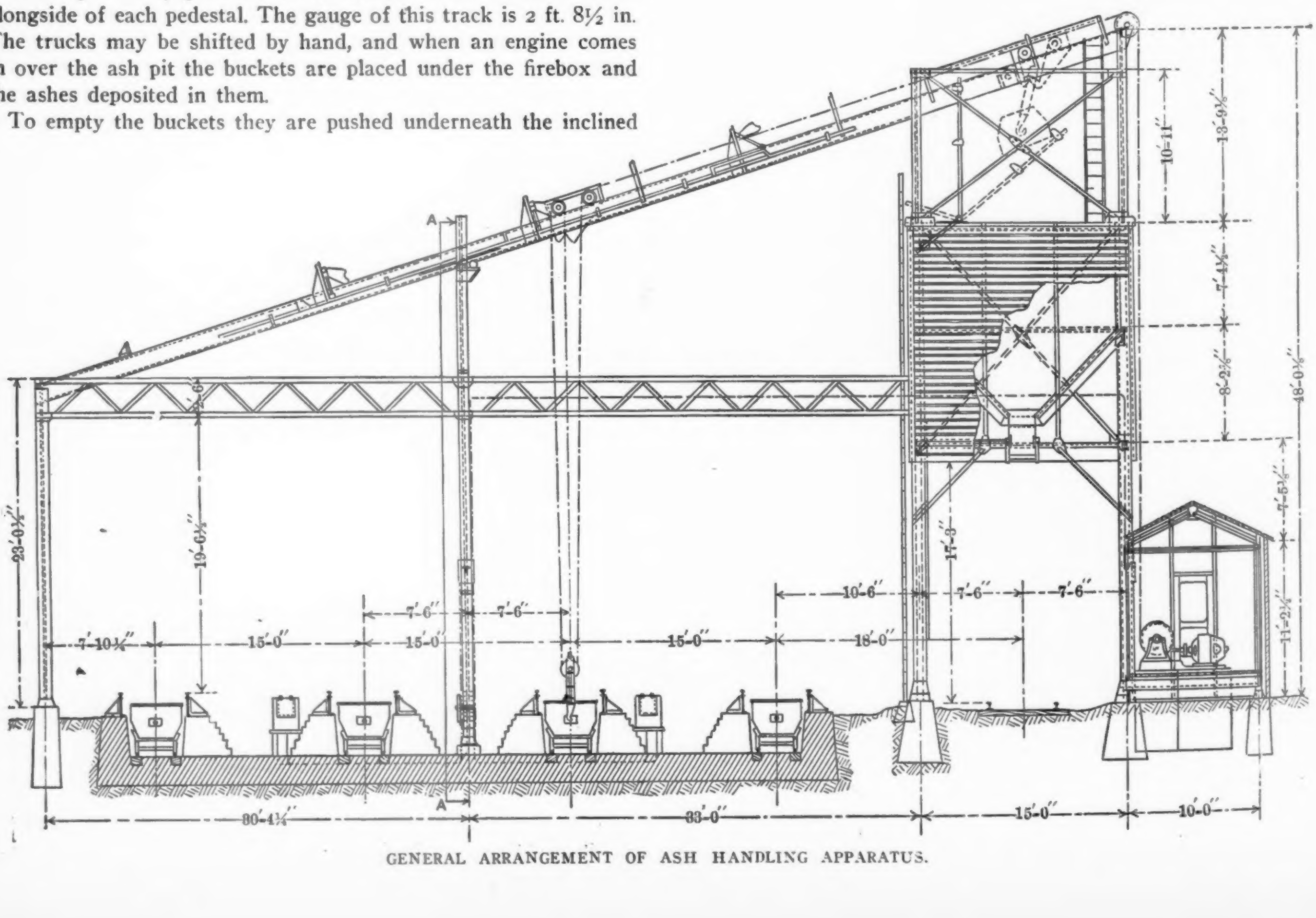
PITTSBURGH & LAKE ERIE RAILROAD.

For the past two years the Pittsburgh & Lake Erie Railroad has had in operation, at McKees Rocks, an ash handling plant which is radically different from the type ordinarily used and has given very satisfactory service. As may be seen from the plan each track under the coaling station connects with two ash pit tracks. The four ash pit tracks are each about 122½ ft. long, and extend over what is practically one large pit. The bottom of the pit is of concrete, 2 ft. thick, and is carefully designed so that it will drain off quickly. The 80-lb. track rails are supported on 15-in. I beams, carried on vitrified brick pedestals, spaced 5 ft., center to center. On each ash pit track are 6 buckets, each having a capacity when loaded level of 45 cu. ft. These rest on trucks, which run on 20-lb. rails spiked to 6 in. by 8 in. by 3 ft. timbers embedded in the cement bottom alongside of each pedestal. The gauge of this track is 2 ft. 8½ in. The trucks may be shifted by hand, and when an engine comes in over the ash pit the buckets are placed under the firebox and the ashes deposited in them.

To empty the buckets they are pushed underneath the inclined runway, which spans the four tracks and passes over the ash bin at its upper end. The buckets are raised and conveyed to the bin and dumped by a hoist and a trolley on the run-way, operated by a winding drum driven by a 15 horse-power Crocker Wheeler motor in the small house on the ground beside the ash



PLAN SHOWING LOCATION OF ASH PITS.

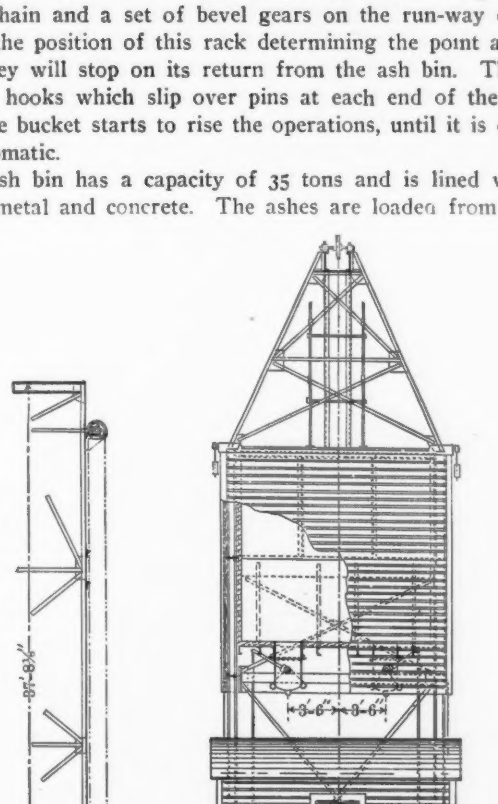


GENERAL ARRANGEMENT OF ASH HANDLING APPARATUS.

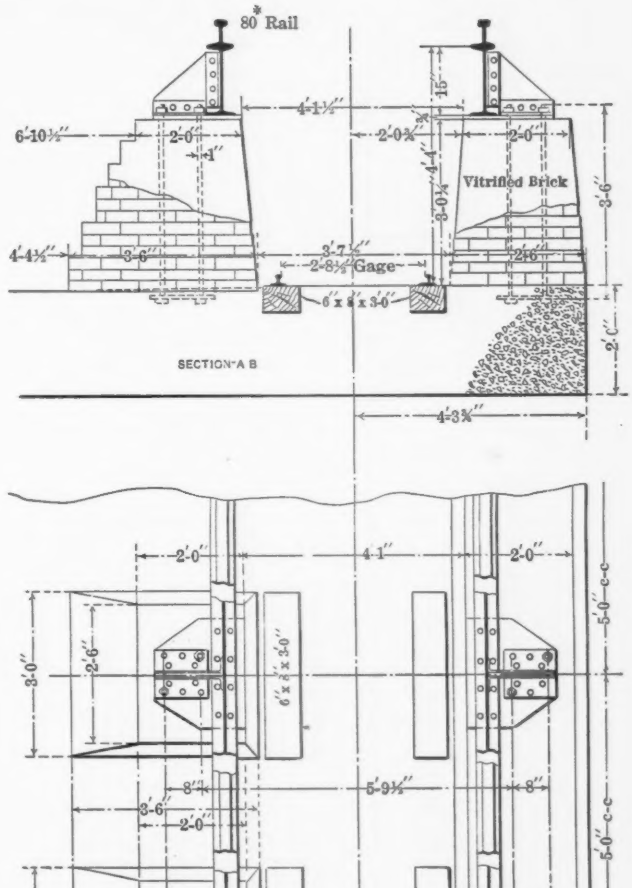
VIEW OF ONE SECTION OF THE ASH PITS.

bin. The motor is governed by two controllers, one between the first and second tracks and the other between the third and fourth tracks, as shown in the illustrations. The trolley may be made to stop at will over any track by manipulating the large hand wheel at the side of the middle column, which through a gear driven chain and a set of bevel gears on the run-way operates a rack, the position of this rack determining the point at which the trolley will stop on its return from the ash bin. The hoist has two hooks which slip over pins at each end of the bucket. After the bucket starts to rise the operations, until it is dumped, are automatic.

The ash bin has a capacity of 35 tons and is lined with expanded metal and concrete. The ashes are loaded from the bin

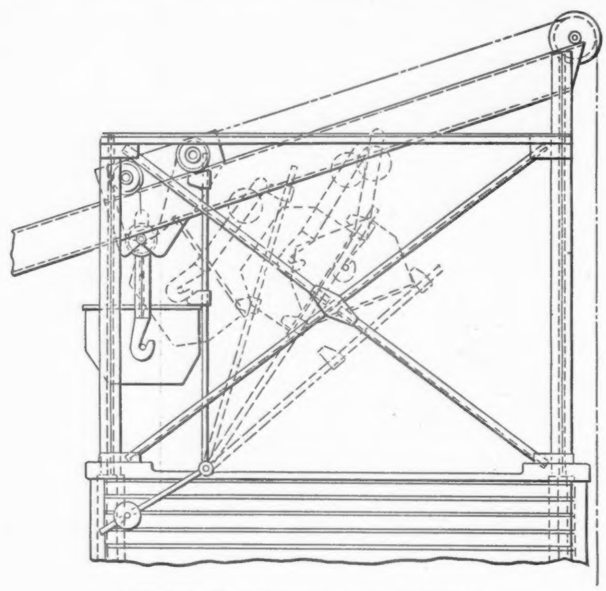


SECTION AND END VIEW OF PLANT.



DETAILS OF ASH PIT CONSTRUCTION.

directly into steel hopper cars, the tracks upon which these cars run being a continuation of the coal supply track, so that when a coal car has been unloaded it may, if desired, be shifted to the ash bin. The coaling plant and the ash handling plant are operated by one man, it being only necessary for him to empty the



METHOD OF EMPTYING THE BUCKETS.

ash buckets after a number of them have been filled. As the ashes are dumped directly into the buckets and the remainder of the operations are performed by machinery and gravity, the amount of labor required is greatly reduced, and the ashes do not have an opportunity of freezing during the winter. This apparatus was designed and installed by Heyl & Patterson, Inc., of Pittsburgh.

Government Ownership of Railways.—I am opposed to government ownership—

First, because existing government railroads are not managed with either the efficiency or economy of privately managed roads and the rates charged are not as low and therefore not as beneficial to the public.

Second, because it would involve an expenditure of certainly twelve billions of dollars to acquire the interstate railroads and the creation of an enormous national debt.

Third, because it would place in the hands of a reckless executive a power of control over business and politics that the imagination can hardly conceive and would expose our popular institutions to danger.

The supervision proposed need not materially reduce the legitimate operation of individualism in railroad enterprise. It will indeed limit the opportunity to accumulate enormous fortunes through overcapitalization or secret rebates, but the legitimate profit which comes from close attention to operation, to efficiency of service and economy in details and from broad conceptions of new methods of reducing cost without impairing the service will not be disturbed in the slightest.—*From Secretary Taft's Columbus Speech.*

Co-operation.—Not only do we need greater co-operation between the railways and the general public, but we need greater co-operation within the railways themselves. The time was when the general manager was, to use a slang expression, "the whole thing." He carried his office under his hat; he knew every shipper on the road, and every employee. That day has gone by, and we have come to a highly specialized and highly differentiated organization where the "right hand frequently does not know what the left hand is doing." For that reason, I preach co-operation every time I have a chance, for surely the best results can only be obtained when every department of the railroad works in harmony and co-ordination with every other.—*Mr. F. A. Delano, President of the Wabash Railroad, before the Traffic Club of Chicago.*

SERVICE TEST OF HIGH SPEED TOOL STEELS.

Lake Shore & Michigan Southern Railway.

A comparative test of tool steels, to be of any value to the average railroad shop, must be made under service conditions and extend over a considerable period of time, so as to take into consideration the effect of breakage and redressing and to average the conditions under which the cutting is done. One tool steel representative will present an argument to the effect that although his steel is more expensive than some others, yet in the long run it is the most economical. Another will argue that his steel is cheaper, and although it may be a little more brittle or wear faster, yet when everything is taken into consideration it will prove the least expensive. Ordinarily the shop managers are accustomed to judge the merits of the various steels by working them to the limit of their capacity under a short test, but this gives no basis for determining the final result under service conditions.

At the Collinwood shops of the Lake Shore & Michigan Southern Railway a series of records have been kept, extending over a year or more, which, although they required only a very small expenditure of time on the part of those interested, contain data from which it is possible to calculate accurately the efficiency of the various makes of steel which were used. No attempt has been made to keep a record of tools other than those used on the tire turning lathes, as the greater part of the high speed tool steel is purchased for that purpose and after the tire turning tools have become too small they are worked up into smaller tools for the other machines.

The method of keeping the records is as follows: All brands of high speed steel for use on the wheel lathes are stamped with

SERVICE TEST OF HIGH SPEED STEELS.

January 1 to July 1, 1906.

MAKE OF STEEL	A	B	C	D	D
Size of tool, ins.	1½x2½	1½x2½	1½x2½	1½x2½	1½x3
Lbs. of metal removed	4255.06	17003.23	3228.88	29423.19	27160.11
Times re-tempered	3	3	2	7	1
Times dressed due to wear	7	4	2	14	18
Times dressed due to breakage	1	3	1	28	14
Total number of dressings	11	10	5	49	33
Lbs. of metal removed per dressing	386.82	1700.32	645.77	600.47	823.03
Lbs. tool steel used per dressing	2.25	3.428	2.25	2 43	3.58
Cost of tool steel per 100 lbs. metal removed (cents)	32.	11.2	23.	26.7	28.7
Efficiency*	17.1	49.6	28 7	24.7	23.0

*Assuming 1000 lbs. of tire steel removed per lb. of tool steel equal to 100 per cent.

a letter or sign to designate the make and a number is given to each tool so that an individual record may be kept of it. The tool grinder makes note of every time the tool is brought to him for grinding and at the same time records, from information which has been chalked on the tool by the machine operator, the number of tires that have been turned by it since the last dressing and the size of each tire; also whether the cause of regrinding is due to wear or to breakage and whether it has been retempered. The weight of the tool before and after dressing is also noted. In a test of this kind it would, of course, not be feasible to weigh the cuttings from each tire, or part of tire, turned by each tool, but the amount of metal removed is based on the results of a careful investigation from which the average amount of metal removed for each different size of tire was determined. As the average amount removed from a tire 80 in. in diameter is less than 200 lbs., and from a 61 in. tire only about 150 lbs., it will readily be seen that a sufficient number of tires were turned by most of the different steels tested, so that the use of average figures should give fairly accurate results.

The accompanying tables show the results of the tests for two periods, one for the first six months of 1906 and the other for the last six months. The different makes of tool steel are designated by the letters of the alphabet. The tools were all ground to a uniform size and shape on a Sellers tool grinder. Data was kept for roughing tools only, the diamond point clearance angles being: Front or end clearance, 9 degs.; top rake, back, 10 degs.;

top rake, side, 0 degs.; side rake, 9 degs. The size of the tools for the first test was the same in all cases except that steel D was tested in two sizes. During the latter part of the year the tools were all of the larger size, 1½ x 3 in., except steel A which was tested in the smaller size only.

The larger size tools show a considerably higher efficiency, due to the reduction of breakages, and while the amount of tool steel used per dressing is increased with the larger size, the pounds of metal removed per dressing is greater in proportion except in the case of steel B. Steels A and C were hardly used extensively enough during the first six months to insure accurate results with the use of average figures for the amount of metal removed, but the other makes and all of those tested during the second period, were used on a large enough number of tires to insure a fair degree of accuracy.

For the 1½ x 2½ in. size tools steel B has by far the best record. Comparison of the results for the two sizes of steel D for the first six months would indicate that there was no advantage in using the larger size steel, except that the number of breakages was reduced, although the greater amount of tool steel used per dressing more than offset this. As the cost of tool steel per 100 lbs. of metal used, as shown in the tables, is based on the first cost of the tool steel only, and does not consider the actual cost of redressing and retempering, the larger size tool would probably prove more economical in this case because of the smaller number of breakages. It would be a simple matter to include the cost of redressing in the figures upon which the efficiency is based. Except in this one instance a comparison of the results of the two sizes of tools shows a considerable advantage in favor of the larger size.

During the last half of the year the larger size tools were tested. Steels C and E are about evenly matched and gave

SERVICE TEST OF HIGH SPEED STEELS.
July 1, 1906, to January 1, 1907

MAKE OF STEEL	A	B	C	D	E
Size of tool, ins.	1½x2½	1½x3	1½x3	1½x3	1½x3
Lbs. of metal removed	13891.78	92932.114	53037.93	49751.67	22297.85
Times re-tempered	6	22	11	29	5
Times dressed due to wear	9	27	18	17	8
Times dressed due to breakage	0	6	2	15	0
Total number of dressings	15	55	31	61	13
Lbs. of metal removed per dressing	926.1	1689.7	1710.9	815 6	1715.2
Lbs. tool steel used per dressing	4.4	3.6	2.3	4.4	2.15
Cost of tool steel per 100 lbs. metal removed (cents)	26.2	11.7	8.9	35.6	82.2
Efficiency*	21.	47.	74.5	18.5	79.7

*Assuming 1000 lbs. of tire steel removed per lb. of tool steel to equal 100 per cent.

very much better results than any of the other makes, steel E having some slight advantage over C, apparently largely due to the fact that steel C suffered from breakages. Steel B made a very good record as far as the pounds of material removed per dressing is concerned, but the pounds of tool steel used per dressing was very much greater than for C and E.

With a record of this kind, the keeping of which entails practically no expense, but serves to interest the workmen in the output, the shop manager has an accurate and definite basis upon which to draw conclusions as to the make of steel which will do the best work with the greatest degree of economy.

TRADE BETWEEN UNITED STATES AND LATIN AMERICA.—During the year ending June 30, 1907, the value of the imports from Latin America to United States amounted to $360,000,000; the exports from United States to Latin America amounted to $250,000,000.

CANADA'S POPULATION.—Figures compiled by the Census and Statistics Department of the Canadian Government show that the population on April 1, 1907, was 6,504,900, representing an increase of 1,133,586, or more than 21 per cent., in six years.

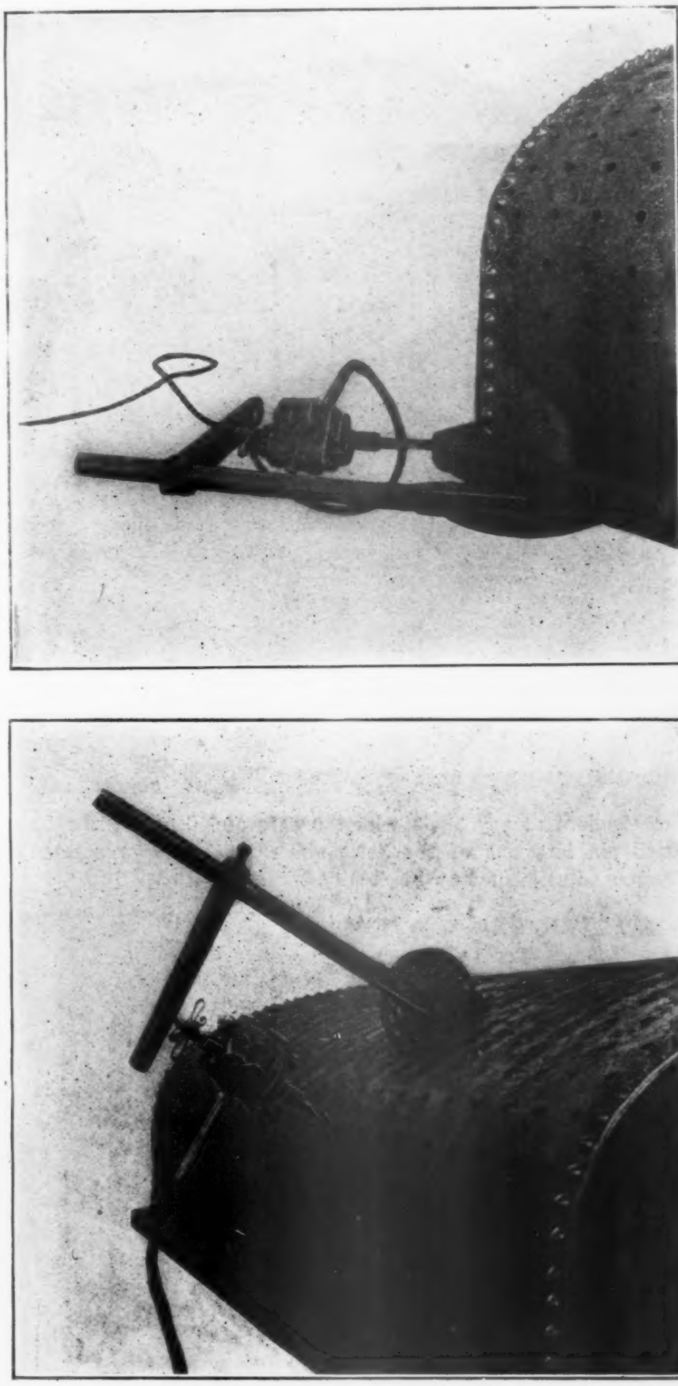
THE TRAVELING ENGINEERS' ASSOCIATION.—This association will hold its fifteenth annual meeting at Chicago on September 3, 4, 5 and 6.

A HANDY DRILL POST.

BY F. G. DE SAUSSURE.

The difficulties attending the satisfactory fastening and adjustment of a drill post or "old man" for work on curved surfaces, such as boiler shells and fire-boxes, are well known to all shop mechanics. There have been many temporary makeshifts fixed up to overcome the trouble in special cases which were thrown away as soon as they had answered their purpose, and it was up to the next man to conjure up something for himself.

For correcting this state of affairs at the Hornell shops of



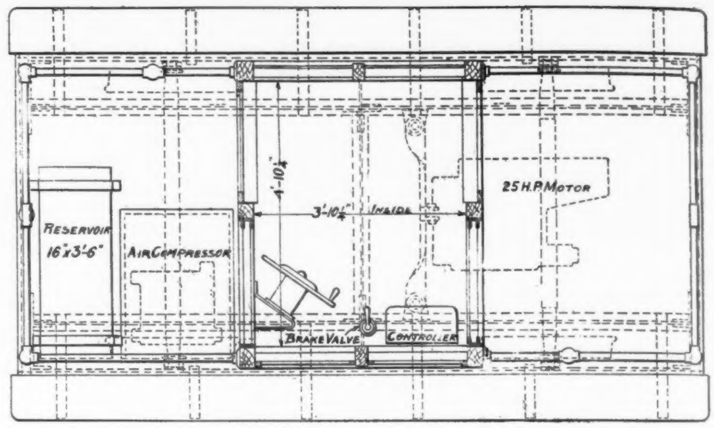
A HANDY DRILL POST.

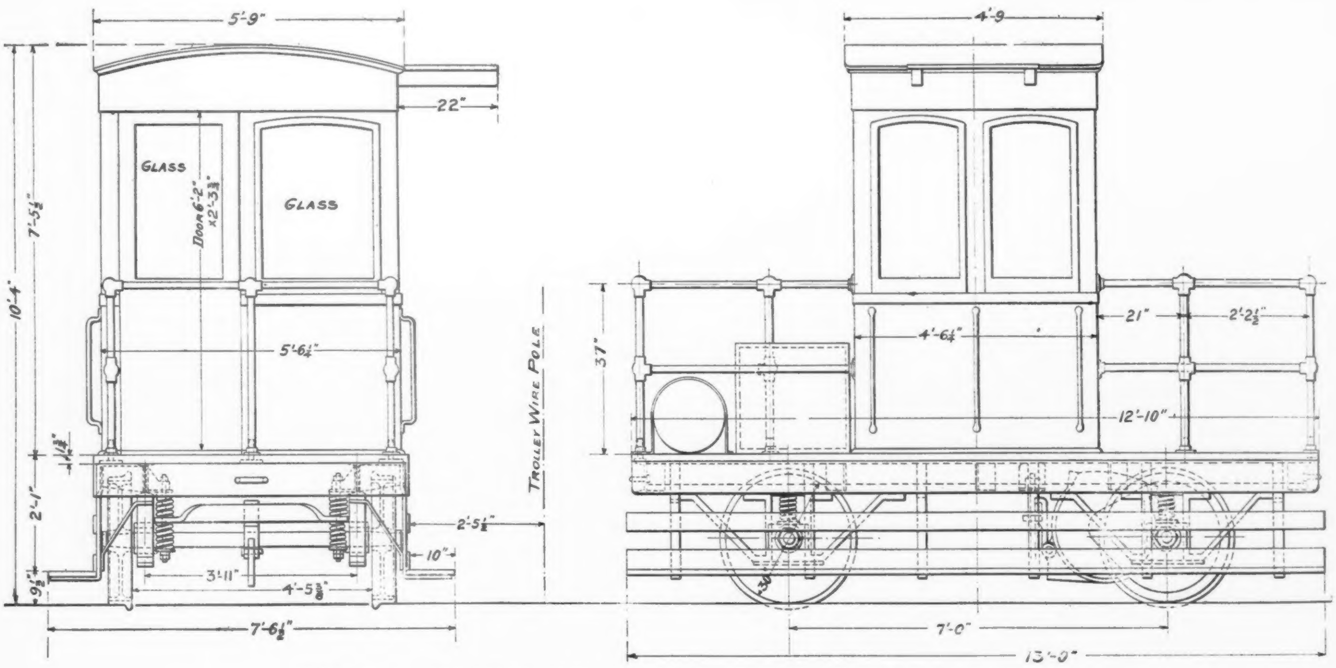
the Erie Railroad, Mr. Thomas Kuhn, foreman boilermaker, has designed and patented a device which while answering all the purposes of the rigid foot drill post is also available for convenient adjustment on curved surfaces.

As will be seen in the illustrations, the only material difference in this device from the usual drill post is in the construction and method of securing the base. The base here consists of a semi-circular piece of boiler plate ½-in. thick, flanged so as

to leave a 3-in. right-angle turn and a full half circular base. In the center of this base a ¾-in. hole is drilled and 1⅜ in. from the circumference a series of equally spaced holes are also drilled. The right-angle flange is provided with ¾ x 2⅜-in. slots located ⅞ in. from each end, and through these slots pass the bolts that are to secure the device to its support.

The standard is of forged soft steel drawn square 10 in. from the end, and in this square portion a slot ⅝ x 6½ in. is cut and two holes ¾ in. diameter and 3⅞ in. apart, drilled at right angles to the slot, permit pins to be dropped through the standard and base, the back pin acting as a pivot. By placing





ELECTRIC CAR FOR HUMP YARD—LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

the standard at any angle with the base and dropping the forward pin into one of the holes along the circumference, any desired adjustment may be obtained.

ELECTRIC CAR FOR HUMP YARDS.

In connection with the operation of large hump or gravity yards it is necessary to provide some means for quickly transporting the switchmen from the place where they leave the cars back to the hump. A light electric car has been constructed at the Collinwood shops of the Lake Superior & Michigan Southern Railway for use in the yards at that place. The distance from the end of the yard to the hump, 1,750 ft., is traversed in about 60 seconds. A gasoline motor car was used formerly, but did not give satisfaction.

Electric current is transmitted from the power house at the repair shops, about one mile distant. The general construction of the transmission line is shown in the photograph. The current is furnished by a 40 kw. Crocker-Wheeler motor generator set, size 35-D, the primary side of which is wound for 250 and the secondary for 550 volts. It operates at a speed of 1,150 r. p. m. The set is large enough for two cars, although at the present time it is furnishing power for only one.

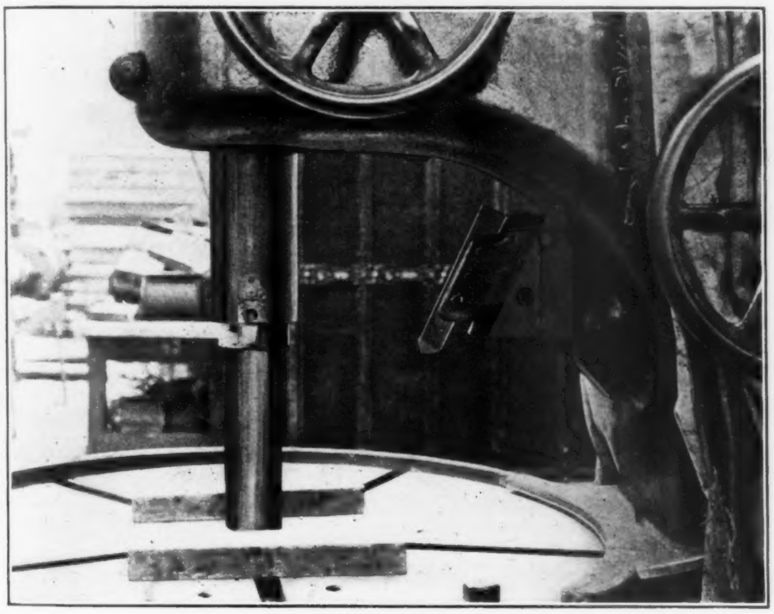
The car is of simple and light construction. The end sills are

ELECTRIC CAR FOR HUMP YARDS.

7 in., 9¾ lb., channels and the two longitudinal sills 7 in., 15 lb., I-beams. The connection of the side plate to the floor timbers is reinforced by an angle iron. Thirty-inch steel tired wheels are used and the axles are fitted with Timken roller bearings. A 25 h.p. No. 131 Westinghouse mining motor drives the axle through gearing. A Westinghouse motor-driven air compressor, type SM-1, is used in connection with the air brakes and has a capacity for 15 cu. ft. per minute. The compressed air reservoir is 16 in. in diameter and 3 ft. 6 in. in length. An electric heater in the cab was furnished by the Simplex Electric Heating Company of Boston.

BORING MILL FOR DRIVING BOXES.

A Putnam car wheel boring machine at the Collinwood shops of the Lake Shore & Michigan Southern Railway has recently been changed to adapt it for boring and facing driving boxes. It has been equipped with a new boring bar which extends down through the table. The table has been bored out and fitted with a bronze sleeve to guide the bar. The cutting tool is held in place by a sliding wedge and the tool holder is adjusted by means of a screw. The horizontal head, which was formerly used for facing the hubs of wheels, was found to be too low for a 12 in. driving box. This was overcome by making a new sliding ram with the head offset enough to take in the deepest driving box. The tool is carried in a head, which may be adjusted by a screw. A guard or shield has been placed around the edge of the table to prevent the clothes of the operator being caught by it. Canvas curtains are arranged so that the machine may be encased when it is operating and thus prevent the chips from being spread broadcast over the floor. The table revolves at the rate of 44 r. p. m. with a minimum speed of 4½ r. p. m. and is driven by a 10 h.p. motor. Three vertical feeds are provided, 7½, 4¾, and 3½ in. per minute. The maximum horizontal feed is at the rate of 3¾ in. per minute and the minimum 1¾ in. per minute.



BORING MILL FOR DRIVING BOXES.

RAILWAY STATISTICS.

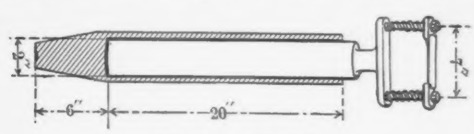
During 1905 there came about no change in the order of leading countries with regard to the length of their respective railway systems. After the United States, with its total of 219,800 miles, there follow the German Empire with 35,300 miles, European Russia with 34,360 miles, France with 29,042, British India with 18,778 miles, Austria Hungary with 23,939 miles, Great Britain and Ireland with 22,780, Canada with 20,717, the Argentine Republic with 12,482 miles, Mexico with 12,300 miles, Brazil with 10,503 miles. Italy with 10,180 miles, Spain with 10,180 miles, and Sweden with 7,928 miles. The other countries, which are not mentioned, possess less than 6,250 miles each.

With regard to the railway mileage as compared with the superficial area, Belgium still heads the list of countries, it 62½ square miles be taken as the unit of comparison. Thus, Belgium has for every 62½ square miles 15.4 of railroad track, Saxony has 12.4 miles, Baden has 15.2 miles, Alsace-Lorraine have 15.2 miles, Great Britain and Ireland have 12½ miles, the German Empire has 6½ miles, Switzerland has 6½ miles, Würtemberg has 6.4, Bavaria has 6.2, and Prussia has 6.1 miles. In the case of the other continents the comparison is at a much lower rate; in the United States it falls to only 2.4 miles, but in 1904 it had 2.75 miles, because the returns for 1905 include Alaska, with its huge area and comparatively small railway system; without reckoning Alaska the proportion for the United States was 2.8 miles. In the other countries the proportion comes out only at a fraction of a mile.

With regard to population, taking 10,000 people as the unit, the Colony of Queensland comes first with 66.2 miles per 10,000 inhabitants. In the other Australian Colonies the proportion is very favorable, owing to the sparse population; the United States have 18 miles; in Europe, Sweden heads the list with 15.4 miles; and then follow France, with 7.44 miles; Belgium, with 6.54 miles; Germany, with 6.25; and Great Britain, with 5.5 miles.—*The Engineer (London).*

HOLDING ON BAR.

An interesting holding on bar for rivets up to ½ in. is in use in the McKees Rocks boiler shop of the Pittsburgh & Lake Erie Railroad, and is shown in the illustration. The springs not only relieve the shocks and make it easier for the man, but it is possible to drive the rivets faster, since the bar returns more quickly to the head of the rivet when the shock jars it. It is also



HOLDING ON BAR.

possible to drive a better head with this bar. Under a test twelve ⅝-in. rivets have been driven in a minute; twelve hundred ⅜-in. rivets can be driven in 10 hours and more than this with improved facilities for heating the rivets. The bar was devised by Mr. John B. Smith, boiler shop foreman, and we are indebted to Mr. L. H. Babcock, one of the boiler makers, for the sketch.

ROUND THE WORLD IN FORTY-ONE DAYS.—The tour of the world in 80 days, which formed the basis of one of Jules Verne's fascinating romances about 35 years ago, would seem a very slow performance nowadays. Lieut.-Colonel Burnley-Campbell, in a letter to the *Times,* recently described how he did it in little more than half that time. Traveling by the Canadian Pacific route, he left Liverpool on May 3rd, reached Vancouver on May 14th, and Yokohama on May 26th. Departing thence next evening he traveled across the island by rail to Tsaruga, and sailing from that port, a few hours later landed at Vladivostok on May 30th, where he caught the trans-Siberian train for Moscow, and arrived there on June 10th, and finishing the journey via Warsaw, Berlin, Cologne, and Ostend at Dover on June 13th. The time consumed on the journey was thus 40 days, 19½ hours, and another seven hours would have enabled him to reach Liverpool. The journey shows what the Siberian railroad has done in increasing the rapidity of communication, for before that line was constructed the feat would have been impossible.—*The Mechanical Engineer.*

WEALTH PER CAPITA.—The wealth per capita is $1,125 in the United States as a whole, $1,455 in Great Britain, $1,228 in France, $751 in Germany, $1,247 in Australia and $2,800 in California.

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Advertisements.—*Nothing will be inserted in this journal for pay,* EXCEPT IN THE ADVERTISING PAGES. *The reading pages will contain only such matter as we consider of interest to our readers.*

Contributions.—*Articles relating to Motive Power Department problems, including the design, construction, maintenance and operation of rolling stock, also of shops and roundhouses and their equipment are desired. Also early notices of owcial changes, and additions of new equipment for the road or the shop, by purchase or construction.*

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CONTENTS

* Illustrated articles.

We hear much as to the advantages of high speed tool steels in railroad shops, but it is doubtful if many of our shop managers have any definite idea as to how much these steels are costing them to do a certain amount of work, or as to the comparative advantages of the various makes of these steels. The description of the service tests made at the Collinwood shops, page 348, is of value in this connection, as it outlines a simple, inexpensive method of obtaining this information with a fair degree of accuracy.

DISTRIBUTION OF LABOR CHARGES IN A RAILROAD REPAIR SHOP.

At the main repair shops of one large railroad system in which 454 locomotives were repaired during the past year, 231 of them at a labor cost of more than $400 apiece, the distribution of the cost of labor was as follows:

	Per Cent.
Erecting Shop	30.2
Machine Shop	25.6
Boiler Shop	18.8
Smith Shop	9.1
Tin Shop	6.1
Cab, Tender Frames and Trucks	4.4
Paint Shop	2.0
Roundhouse and Miscellaneous	3.8
Total	100.0

The total labor cost was in excess of $250,000. These figures convey a good idea of the relative size and importance of the various departments.

TEAM-WORK.

The necessity of team-work and co-operation in and between each department of a railroad has been mentioned many times in these columns. How an official, or a department, who is continually looking for an opportunity to find fault with another official or department, or how one department going on regardless of the interests of and without co-operating with the others, can hope to make a real record or success of its work, is hard to understand.

Mr. Wheatley's article, on another page, suggests a number of ways in which the operating department can help the mechanical department to accomplish better results. The last paragraph which suggests that the title of the master mechanic be changed to assistant superintendent is a little startling and should receive careful consideration. The idea is to automatically secure closer co-operation between the two departments and to open up greater opportunities for the motive power official.

SYSTEM.

The following sentiments, which were expressed by one of our friends who is engaged in trying to introduce some system into motive power affairs, is worthy of consideration.

"A better and more expensive engineer was needed to stop the flow into the Salton Sea when the break had been made than is needed to keep the Colorado River where it belongs now the break is closed. Sensational work, such as damming the Colorado River, putting a ship off the rocks, or keeping engines going after they are in such shape that every one is looking on, is more exciting and pleasing than plodding along with systematic detail daily work. Systematic detail work keeps everything going properly but cuts out the chance of having the limelight thrown upon the performer."

"This element of pride and self-glory makes the ordinary man of authority plant his feet and balk when system is proposed. He wants to do everything himself and get all the glory. If records and system are applied he feels that a set of clerks will do his work. He knows that if system is applied rigidly enough the proper course will be as plain as the channel into a harbor marked with lighthouses and buoys. Columbus is more of a hero than the sea captain of to-day who courses the ocean with charts, lighthouses and marked channels to guide him. Systematic records are the lighthouses and buoys which mark the channels through which the man in authority should sail his

affairs. This man, however, realizes that his personal glory dwindles when he sails in charted seas. Hence he says no system for me."

The suggestion might be made that those who fear that their personal glory will dwindle when sailing in charted seas should "get busy" and chart the seas. There is certainly more glory in charting than in sailing to someone else's charts. Instead of saying "no system for me," let them "get busy" in making a system and then it will not be necessary for it to be proposed to them.

THE SUCCESSFUL MOTIVE POWER DEPARTMENT OFFICIAL.

Here are the principles or rules which were followed by one of the most successful of our motive power officials.

I.—"Cover current practice with circulars giving explicit instructions in detail for all employees. Make these instructions definite and keep them strictly up to date."

II.—"Establish measures of expenditure for the maintenance and repairs of equipment, fuel, etc., and see that they are not exceeded." This can only be done by carefully studying and analyzing conditions and making a fair allowance for the various items, or in other words, establishing a limit which those interested should strive to reach and keep within. Such a limit should, of course, be a reasonable one and such that can be reached by careful, systematic effort. It is then a matter for those in charge to follow up cases where the limit is exceeded and apply the proper remedies. This idea has been tried to some extent, in various ways and in varying degrees, on several roads and in some instances has failed because too little attention was paid to analyzing conditions.

An extreme illustration of how this idea has been developed even to the point of setting a limit for each man to reach and determining his efficiency is shown in the paper on "Shop Cost Systems," which was presented before the Master Mechanics' Association by Mr. A. Lovell and reprinted on page 274 of our July issue, or in the paper by Mr. Harrington Emerson on "The Methods of Exact Measurement Applied to Individual and Shop Efficiency at the Topeka Shops of the Santa Fe" on page 221 of our June issue, or in the paper by Mr. J. F. Whiteford on "Roundhouse Betterment Work" on page 216 of our June issue.

Another illustration of this idea is that of placing locomotives on an allowance plan or establishing a cost at which each engine should be maintained. To be a success the performance sheets must be more accurately and carefully compiled and more promptly issued than is now done on many roads. This system has been used on the Northern Pacific Railway for some years. It is also in use on the Canadian Pacific Railway. The method of keeping the performance sheets on the latter road was considered at length in an article by Mr. H. H. Vaughan in our June, 1906, issue.

III.—"Cut out lost motion everywhere by keeping a minute record of pay-rolls and other cost statistics." In order to digest and quickly draw accurate conclusions from the mass of statistics which pass through the hands of the motive power officials they must be plotted graphically. The method of doing this in the mechanical department of the Northern Pacific Railway was described by Mr. L. A. Larsen, on page 451 of our December, 1905, issue. This system was first used extensively on the Chicago, Great Western Railway.

IV.—"Know positively what is doing."

V.—"Know what everything costs."

VI.—"Know what it ought to cost."

VII.—"Establish an organization which is automatic and will not suffer by the loss of an official—even the highest." This is, of course, the most difficult part of the problem. It depends to a large extent on having fully carried out and established the principles noted above, and to do this requires time and loyal and enthusiastic assistants. Unfortunately too many of the men who have undertaken the problem and have gone far toward its solution have found it to their advantage to leave the service and go where their efforts were appreciated to a greater extent. Fortunately some of the railroads have realized the importance of keeping such men. It is to be hoped that more of them will do so.

THE ECONOMICAL UTILIZATION OF LABOR.*

By Henry L. Gantt.

Those who have given even superficial study to the subject of labor are beginning to realize the enormous gain that can be made in the efficiency of workmen if they are properly directed and provided with proper appliances. Few, however, have realized another fact of equal importance, namely, that to maintain *permanently* this increase of efficiency the workman must be allowed a portion of the benefit derived from it. To successfully obtain a high degree of efficiency, however, the same careful scientific analysis and investigation must be applied to every labor detail as the chemist or biologist applies to his work. Wherever this has been done, it has been found possible to reduce expenses and at the same time to increase wages, producing a condition satisfactory to both employer and employee.

Wherever any attempt is made to do work economically the compensation of the workman is based more or less accurately on the efficiency of his labor. Very fair success in doing this has been accomplished in day work by keeping an exact record of the work done each day by every man and by fixing his compensation accordingly. This method, however, falls very far short of the highest efficiency, for very few workmen know the best way of doing a piece of work, and scarcely any have the ability to investigate different methods and select the best. It often happens, then, that a man working as hard as he can falls very far short of what may be done, on account of employing inferior methods, inferior tools, or both.

We can never be certain that we have devised the best and most efficient method of doing a piece of work until we have subjected our methods to the criticism of a complete scientific investigation. Many people who have been accustomed to seeing an operation performed in a certain way, or even to performing it in that way for a number of years, imagine they know all about it, and resent the intimation that there may be some better way of doing it. Anybody, however, who carefully analyzes the sources of his methods will find that the mass of them are either inherited, so to speak, from his predecessor, or copied from his contemporaries. He will find that he knows but little of their real origin, and consequently has no ground on which to base an opinion as to their efficiency.

Even such a simple operation as shoveling is done very uneconomically in many places. The writer has seen the same shovel used for coal, ashes and shavings, and this when coke forks were available for the shavings. The foreman had apparently given the subject no study and was content if the men were at work. The idea of working efficiently had never occurred to him. This is, of course, an extreme case, but it is a real one, and all degrees of efficiency exist between this and the case where each workman is provided with the proper implement and given a specific task, for the accomplishment of which he is awarded extra compensation.

Having determined thus the amount of work that a man can do, we can usually get it done if we offer the proper wages for doing it, and furnish an instructor who will teach the workman how to do it. If the best method of doing a task is taught to a capable workman to whom good wages is paid for its successful performance, it would seem that we had done enough to assure the work's being done that way permanently. Such, however, is not the fact, for while these conditions will usually produce the desired result, they will not always maintain it, but must be supplemented by a fourth condition, namely, *a distinct loss in wages on the part of the workman unless a certain degree of efficiency is maintained.*

In order to get the best results the following four conditions are necessary: *First.* Complete and exact knowledge of the best way of doing the work, proper appliances and materials. *Second.* An instructor competent and willing to teach the workman how to make use of this information. *Third.* Wages for efficient work high enough to make a competent man feel that they

* Abstracts from a lecture delivered to the Senior Class of Stevens Institute of Technology.

are worth striving for. *Fourth.* A distinct loss in wages in case a certain degree of efficiency is not maintained. These four conditions for efficient work were first enunciated by Mr. Fred W. Taylor, and when they are understood their truth seems almost axiomatic. They are worthy of very careful consideration.

These conditions are really the steps that must be taken to get any piece of work done efficiently: *First.* Learn how to do it right, and how long it should take. *Second.* Teach a workman to do it in the manner and time set. *Third.* Award the workman greater compensation for doing it in the manner and time set than he can ordinarily earn in any other manner. *Fourth.* Make the conditions of pay such that if he fails to do the work either in the manner or time set, he gets only his day's pay.

Let us study these steps one at a time. The first is a scientific investigation of how to do the work and how long it should take. The fact that any operation, no matter how complicated, can be resolved into a series of simple operations, is the key to the solution of many problems. Study leads us to the conclusion that complicated operations are always composed of a number of simple operations, and that the number of elementary operations is often smaller than the number of complicated operations of which they form the parts. The logical method, therefore, of studying a complicated operation is to study the simple operations of which it is composed, a thorough knowledge of which will always throw a great deal of light on the complex operation. Also the time needed for performing any complex operation depends upon the time of performing the simple operations of which it is composed. The natural method, then, of studying a complex operation is to study its component elementary operations. Such an investigation divides itself into three parts, as follows: An analysis of the operation into its elements; a study of these elements separately; a synthesis, or putting together the results of our study.

This is recognized at once as simply the ordinary scientific method of procedure when it is desired to make any kind of an investigation, and it is well known that until this method was adopted science made practically no progress. If it is desired to obtain the correct solution of any problem we must follow the well-beaten paths of scientific investigation, which alone have led to reliable results. The ordinary man, whether mechanic or laborer, if left to himself, seldom performs any operation in the manner most economical, either of time or labor; and it has been conclusively proven that even on ordinary day work a decided advantage can be gained by giving men instructions as to how to perform the work they are set to do. When these instructions are the result of scientific investigation, the gain in efficiency is usually beyond our highest expectations.

It is well known that nearly every operation can be and in actual work is, performed in a number of different ways; and it is self-evident that all of these ways are not equally efficient. As a rule, some of the methods employed are so obviously inefficient that they may be discarded at once, but it is often a problem of considerable difficulty to find out the very best method. It is only by a scientific investigation that we can hope even to approximate the best solution of any problem.

To analyze every job and make out instructions as to how to perform each of the elementary operations requires a great deal of knowledge, much of which is very difficult to acquire; but the results obtained by this method of working are so great that the expenditure to acquire the knowledge is comparatively insignificant.

It has been demonstrated that whether the labor is that of a Pennsylvania Dutch workman in a machine shop, a Hungarian laborer handling stock in the yard of a steel-works, or a skilled cloth handler in a bleachery, the amount of work the average workman does under the ordinary conditions is only about one-third of what can be done by a proper workman under the best conditions. I could give other illustrations of this ratio, which seems to be pretty uniform. In other words, when a man sets his own task, as he virtually does in ordinary day work, he usually does about one-third of what a good man fitted for the work can do under the best conditions.

As a result of our first step or our scientific investigation, we find, in general, that it is possible to do about three times as much as is being done; the next problem is how to get it done. First, I wish to say that no matter how thoroughly convinced we may be of the proper method of doing a piece of work and of the time it should take, we cannot make a man do it unless he is convinced that in the long run it will be to his advantage. In other words, we must go about the work in such a manner that the workman will have confidence in us and feel that the compensation offered will be permanent. When we have established this condition of affairs we are ready to start a workman on the task, which, when properly set after an investigation, is such as can be done only by a skilled workman working at his best normal speed.

The average workman will seldom be able at first to do more than two-thirds of the task, and as a rule not more than one out of five will be able to perform the task at first. By constant effort, however, the best workmen soon become efficient, and even the slower ones often learn to perform tasks which for months seemed entirely beyond them.

If we have at hand such people that already have confidence in us and are willing to do as we ask, the problem of getting our task work started is easy. This, however, is frequently not the case, and a long course of training is necessary before we can teach even one workman to perform his task regularly, for workmen are very reluctant to go through a course of training to get a reward, especially when they are being told on all sides, as is usually the case, that the high price offered will be cut as soon as they can earn it easily.

Buying labor is one of the most important operations in modern manufacturing, yet it is one that is given the least amount of study. Most shops have expert financiers, expert designers, expert salesmen, and expert purchasing agents for everything except labor. The buying of labor is usually left to people whose special work is something else, with the result that it is usually done in a manner that is very unsatisfactory to buyer and seller. It is admitted to be the hardest problem we have to face in manufacturing to-day, and yet it is considered only when the manager "has time" or "has to take time," or on account of "labor trouble." The time to study this subject is not when labor trouble is brewing, but when things are running smoothly and employer and employee have confidence in each other.

Men as a whole (not mechanics only) prefer to sell their time rather than their labor, and to perform in that time the amount of labor they consider proper for the pay received. In other words, they prefer to work by the day and be themselves the judges of the amount of work they shall do in that day, thus fixing absolutely the price of labor without regard to the wishes of the employer who pays the bill. While men prefer as a rule to sell their time and themselves determine the amount of work they will do in that time, a very large number of them are willing to do any reasonable amount of work the employer may specify in that time, provided only they are shown how it can be done and paid substantial additional amounts of money for doing it. The additional amount needed to make men do as much work as they can depends upon how hard or disagreeable the work is, and varies from twenty to one hundred per cent. of their day rate.

These facts are derived from experience and give us a key to the intelligent purchase of labor. For instance, if we wish to buy the amount of labor needed to accomplish a certain task, we must find out exactly and in detail the best method of doing the work, and then how many hours' labor of a man suited to the task, working at his best normal rate and by the methods prescribed, are needed to perform it.

This is simply getting up a set of specifications for the labor we wish to buy, and is directly comparable to a set of specifications for a machine or a machine tool. The man who buys the latter without specifications is often disappointed, even though the manufacturer may have tried earnestly to anticipate his wishes; and the man who buys the former under the same conditions has in the past almost universally found that a revision of his contract price was necessary in a short time. The relative

importance of buying labor and machinery according to the best knowledge we can get, and the best specifications we can devise, is best illustrated by the fact that while the purchase price of a machine may be changed whenever a new one is bought, that of the labor needed to do a piece of work should be practically permanent when it is once fixed. As I have said before, few men can work up to these specifications at first, if they are properly drawn, but many men will try if they are properly instructed and assured of the ultimate permanent reward. Most men will not sacrifice their present wages to earn a higher reward in the future, and even if they were willing, few men could afford to. Therefore, while they are learning to perform the task, they must then be able to earn their usual daily wages, and the reward for the accomplishment of the task must come in the form of a bonus over and above their daily wage.

It is these considerations that lead to the development of the bonus system of paying labor, under which a man always gets his day's wages. If he accomplishes the task in the time and manner specified, he gets in addition a bonus the size of which depends upon the severity of the work. The easiest way to figure such a bonus is to make it a proportion of the time allowed; for instance, if from our time study we find that three hours is a reasonable time for a job that has usually taken from five to ten hours, we set three hours as the time limit and pay the workman one-third more, or for four hours, if he does the work in three hours or less.

If he does it in exactly three hours he gets pay for four hours, or an increase of $33\frac{1}{3}$ per cent. If the work is done in two and one-half hours he gets pay for four hours, or an increase in wages per hour of 60 per cent. If the work is done in two hours his pay is still that which he would ordinarily get for four hours, an increase of 100 per cent. If the study of the work has been carefully done, and the task is properly set, it will but seldom occur that a workman can do in two hours the task for which he was allowed three. We sometimes find, however, that an exceptional man will do in two and one-half hours work that a good man will need three hours for. The large increase of wages such a man can earn amply compensates the exceptional man for devoting his time to the work.

As I have said before, a proper task is always greater than the ordinary workman can perform at first, and must be such as only the most skilled can perform. On the other hand, when the more skilled have been earning their bonus for some time, and the less skilled began to realize that the prize is real and worth striving for, they make every effort to attain it and rapidly improve in skill. This increase in efficiency makes the payment of high wages possible, and it may be added that without efficient labor, permanent high wages cannot be paid indefinitely, for *every wasteful operation, every mistake, every useless move has to be paid for by somebody and in the long run the workman has to bear his share.*

Good management, in which the number of mistakes is reduced to a minimum, and useless, or wasteful operations eliminated, is so different from poor management, in which no systematic attempt is made to do away with these troubles, that a man who has always worked under the latter finds it extremely difficult to form a conception of the former. The best type of management is that in which all the available knowledge is utilized to plan all work, and when the work is done strictly in accordance with the plans made. In other words, that management is best which utilizes labor in the most efficient manner.

The best mechanical equipment of a plant that money can buy avails but little if labor is not properly utilized. On the other hand, the efficient utilization of labor will often overcome the handicap of a very poor mechanical equipment, and an engineer can have no greater asset than the ability to handle labor efficiently.

IMMIGRANTS.—The number of immigrants admitted to the United States during the year ending June 30, 1907, was 1,285,349. The number admitted during the previous year, 1906, was 1,100-735; for 1905, 1,026,499, and for 1904, 812,870. During the past ten years, 7,208,746 have been admitted.

TEAMWORK.

The motto of the *Santa Fe Employees' Magazine* is "Teamwork." The following example of what may be accomplished by intelligent co-operation or teamwork is cited in its August issue:

"Some time ago, with a view of ascertaining the facts in regard to the amount of material held at the shops and by section forces, extra gangs, and, in fact, all material other than that in the custody of the store department, a thorough examination was made, which resulted in the determination to collect and turn back into stock all the material not actually needed for current uses. As the undertaking progressed large amounts of material and supplies were found. Some of this was obsolete and was sold; in fact, special pains were taken to gather up and sell all of the scrap available. The value of material taken back into stock from various sources mentioned above, during the year ending June 30, was $1,035,032.43. The scrap sales amounted to $1,988,793.65."

"Mr. Rice, the general storekeeper of the company, in submitting his report upon this subject, said: 'A great deal of the credit for the proper and prompt handling of scrap is due to the transportation department as well as to the mechanical department. We have had the very best support from both departments in properly taking care of the scrap during the past year. The same holds good with material taken back into stock, all of which has been credited to operating accounts. The figures that I have submitted show plainly the results that can be obtained by hearty co-operation between all departments. As stated before, however, the credit for the large increase shown in the figures is due to no particular person; it is 'teamwork' between the officials and employees of the transportation, mechanical and store departments.' "

LENGTH OF A CURVED LINE.

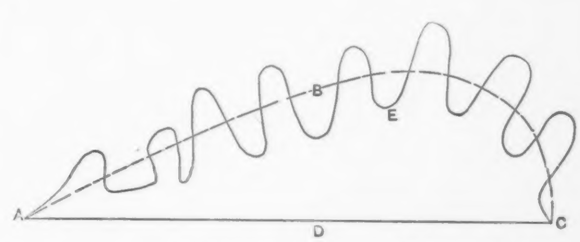
TO THE EDITOR:

On page 309 of your August number I note a method for finding the length of a curved line. This is wrong as can readily be seen by considering the length of the perimeter of a square and a circle, of equal area. Consider a circle and a square each containing 16 square inches. The perimeter of the square will of course follow Mr. Moody's rule and will equal 16 linear inches, but the circumference of the circle will be approximately 14 3/16 inches, making an error in this case of over 12 per cent., which is much more than would result from any but the most careless use of steppers. If the rule suggested was correct, the perimeters of all figures would bear the same relation to their area.

Richmond, Va. L. N. GILLIS.

TO THE EDITOR:

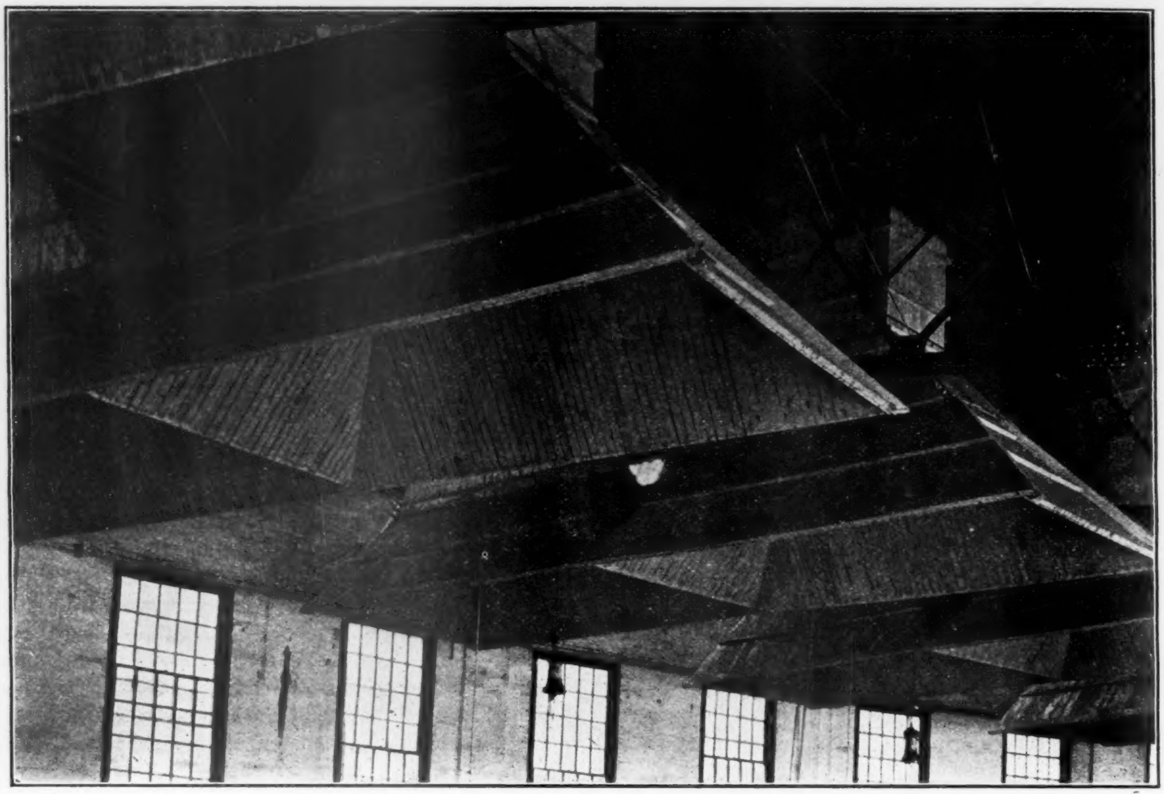
In your August issue you print a communication by W. O. Moody on the "Length of a Curved Line." The theory illustrated is wrong, so obviously so that it is hardly necessary to comment on it.



According to Mr. Moody, if the areas ABCD and AECD are equal, the dotted line ABC and the full line AEC, are of the same length, whereas the full line is really much longer than the dotted line. JOHN E. GARDNER.

Aurora, Ill.

NUMBER OF AUTOMOBILES BUILT.—A French statistician estimates that about 550,000 motor cars have been manufactured in the nine years since the experiments of self-propelled road vehicles first succeeded, and these machines sold for more than $1,000,000,000.



DOUBLE SMOKE JACK—PITTSBURGH & LAKE ERIE RAILROAD.

AN EVOLUTION IN ROUNDHOUSE SMOKE JACKS.

PITTSBURGH & LAKE ERIE RAILROAD.

The Pittsburgh & Lake Erie Railroad was one of the first to experiment with and adopt a smoke jack with a very large opening at the bottom, such as is now coming into quite general use. Fig. 1 shows the first example of this type, which was introduced on that road in 1903. The end doors did not prove satisfactory and the slope to the stack was not steep enough and offered more or less resistance to the smoke and gas. This was succeeded by the type of jack shown in Fig. 2. The end doors were done away with and the slope to the stack was made considerably steeper than on the earlier type, with the result that the smoke and gases passed off more readily. While this was very much more satisfactory than any other type of smoke jack which had been used up to that time, the result was still not all that was to be desired and recently the form of jack shown in Fig. 3 was adopted. This is a double jack, having two openings through the roof, and is of such length that not only does all of the smoke from the stack pass into it, but also any steam from the pop valve and whistle or other parts of the locomotive.

The opening at the bottom, 35 ft. long and 10 ft. wide, is 2½ times as long and about 2½ times as wide as the earlier types. The section through the upper part of each stack of the double jack is a rectangular shape 3 ft. 6 in. wide by 5 ft. long, in place of a circular section 30 in. in diameter as used with the earlier single jack. The area of each stack has therefore been increased from 700 to 2520 sq. in., the total stack opening for the double jack being 5040 sq. in., or seven times as large as that of the older types. The details of the construction are clearly shown on the drawings. The jack is of wood, the side-boards being ¾ x 3½ in. pine flooring thoroughly dried. The T and G joints are painted with fire resisting paint before being laid. The interior surface of the jack is made as smooth as possible to avoid a lodging place for sparks, and is painted with three coats of Quest cold water paint, manufactured by Mr. W. O. Quest, McKees Rocks, Pa. The outside surface below the roof is painted with two coats of white lead linseed oil paint, and the outside surface above

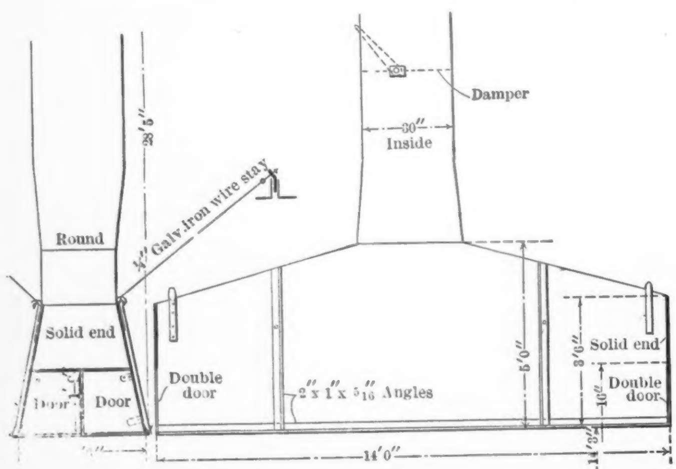


FIG. I.—FIRST TYPE OF SMOKE JACK WITH LARGE OPENING.

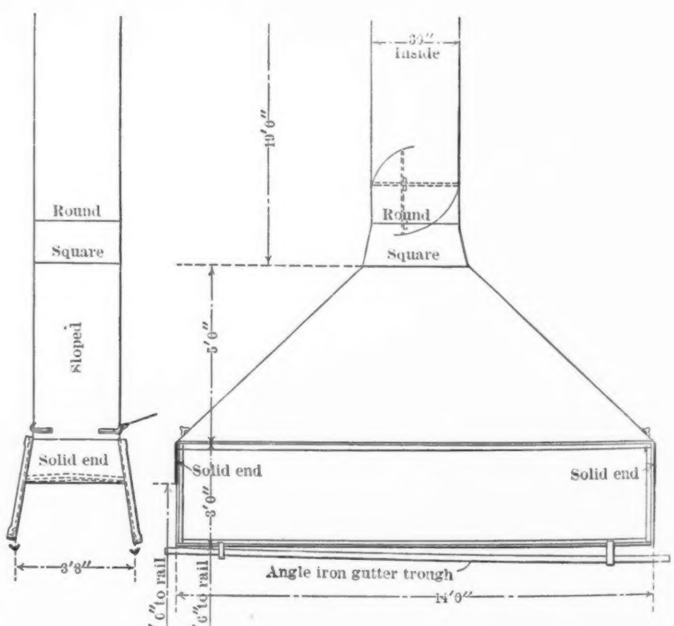


FIG. 2.—SECOND TYPE OF SMOKE JACK.

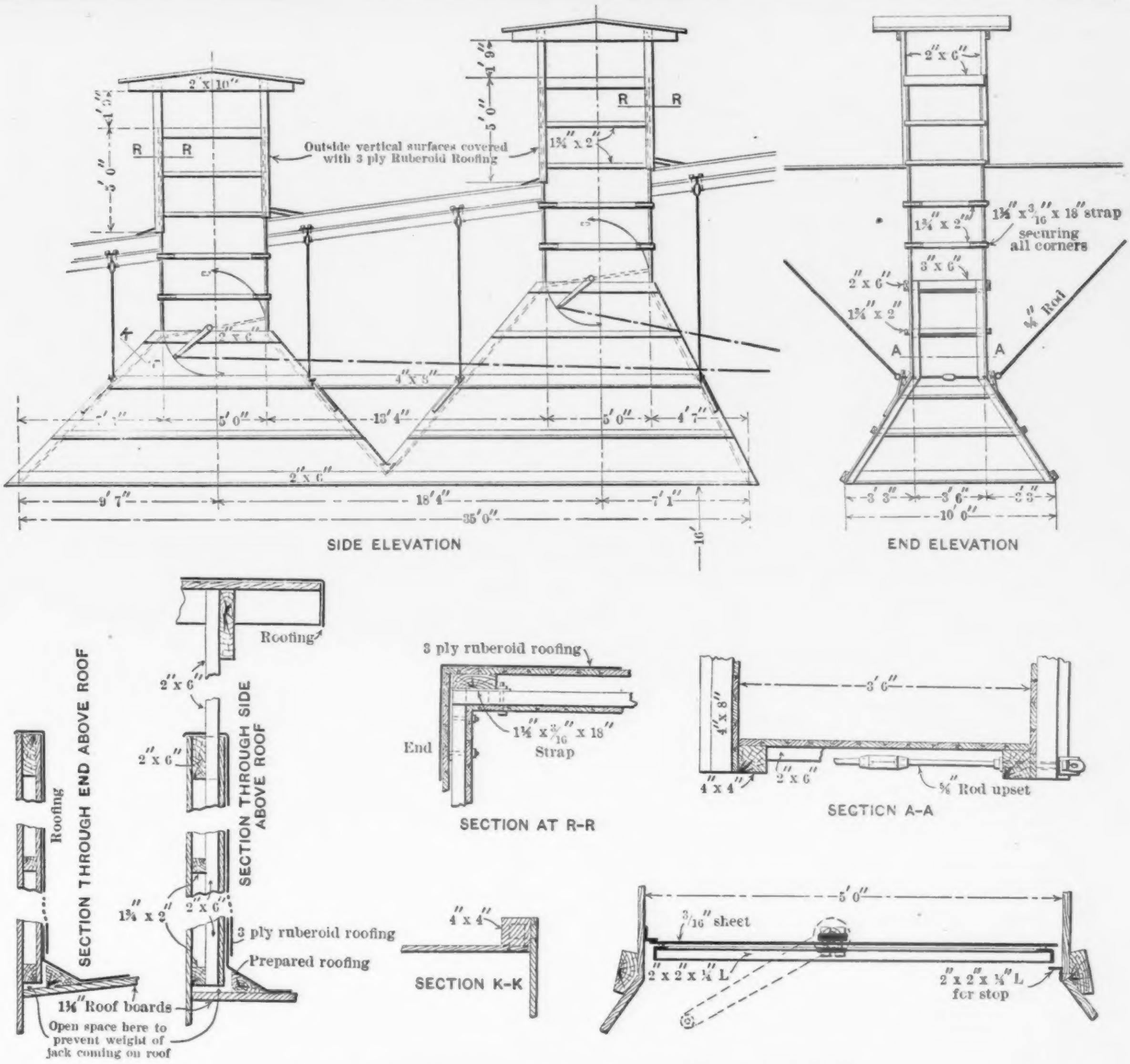
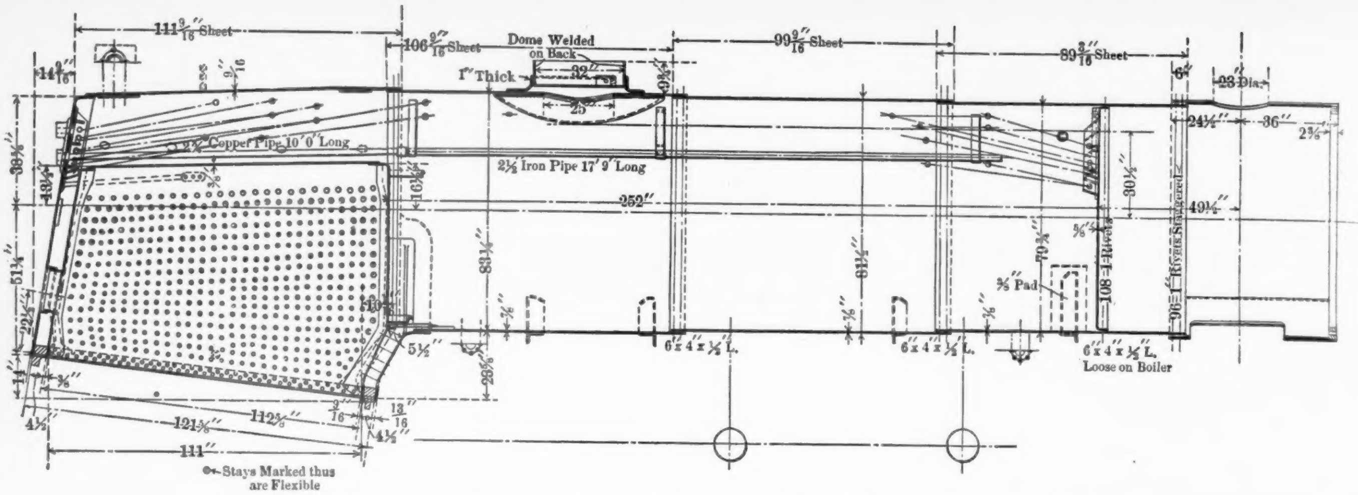


FIG. 3.—ARRANGEMENT AND DETAILS OF DOUBLE SMOKE JACK.

the roof, where Ruberoid roofing is not specified, is painted with three coats of the same paint. These jacks have been in use at three of the roundhouses (Newell, College and New Castle Junction) for some time, and have given very satisfactory results. We are indebted to Mr. A. R. Raymer, assistant chief engineer, for drawings and information.

THE STEAM TRIALS OF THE LUSITANIA.—To those most directly interested in the results of these trials of this great Cunard liner, which is one of the two largest vessels that ever left the ways in a builder's yard, as well as to those who travel over the Atlantic highway, and, indeed, to the nation as well, the evidences of superiority in speed, in comparative absence of vibration, and in general comfort and convenience aboard, must appear eminently satisfactory. But to engineers chiefly, and to those who have watched the progress of naval architecture and engineering ever since the steam turbine seriously challenged the supremacy of the reciprocating engine, the information gained in the engine room of this steamer during her 2,000 miles trial voyage is especially interesting, as it settles, as far as a trial can settle, certain questions about which engineers were divided, and upon which no experimental data on such a scale before existed. In the first place, though the turbine was chosen for this vessel, after careful consideration of the problem, as being the only engine capable of exerting the requisite power in the space accorded to the machinery, doubts existed as to the power which could be developed by this new type of engine built on a design of unprecedented size, and driving screw propellers at a speed some two and a half times that at which marine shafts of comparable size usually revolve. Notwithstanding the absence of information on the working of such gigantic turbines, not to mention the many constructive difficulties which presented themselves, the 64,600-horse-power developed, as measured by the torsion dynamometers, has fully confirmed the calculations, and the ship maintained a mean speed of 25.4 knots over the course, which was considerably better than the contract demanded. To attain such a result without the assistance of experimental facts on a similar scale represents the exercise of the greatest skill and scientific precision, which ought to dispose of the contention sometimes made that steam turbine design is executed by rule of thumb and hit and miss principles rather than by judgment combined with mathematical calculation and such experimental knowledge as is available.—*From the Times (London) Engineering Supplement.*

STUDY MEN.—To attain to the highest success as an engineer you should not only be able to reach correct conclusions quickly when you have the facts before you for direct observation, but you should also have the power to draw correct conclusions quickly from information which comes to you through other men. This power comes largely from knowing men. To attain to the highest success as an engineer you must not be the type of a man who knows how to do things excellently but cannot tell others how to do them—the man who gets knowledge abundantly but can apply it only through his own fingers. Instead of devoting your energy simply to increasing your own output by 50 or even 100 per cent., it is far better—you make yourself more useful to the world—by using your energy to increase the output of each of one hundred men by 10 per cent. The world recognizes this by awarding the prizes to the administrators.—*Mr. John F. Hayford, at the Thomas S. Clarkson Memorial School of Technology.*



LONGITUDINAL SECTION THROUGH BOILER—PENNSYLVANIA RAILROAD PACIFIC TYPE LOCOMOTIVE.

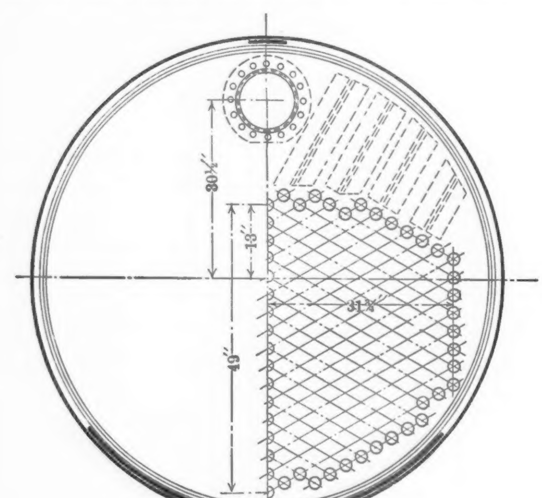
LARGEST PASSENGER LOCOMOTIVE.

PENNSYLVANIA RAILROAD.

In the July issue of this journal, pages 266 and 267, appeared the general elevation, photograph and a brief description, with dimensions, of the largest passenger locomotive ever built, which was recently completed at the Pittsburg shops of the American Locomotive Company, for the Pennsylvania Railroad.

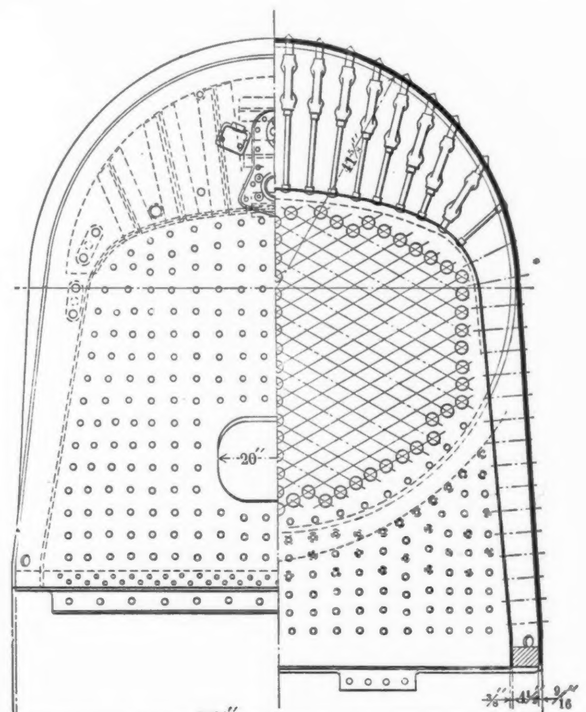
This locomotive has 24 x 26 in. simple cylinders, carries 205 lbs. boiler pressure and weighs in working order 269,200 lbs. The tractive effort with 80 in. drivers, is 32,700 lbs. As supplementary to the general description given in that article the more important details are considered in this article.

Boiler.—The boiler is of the straight top radial stay type, measuring 79¾ in. outside diameter at the front ring and 83¼ in. outside diameter at the dome course. The tubes are 21 ft. in length, 2¼ in. in diameter, and 343 in number. This number of tubes occupies but 27.2 per cent. of the area of the boiler at the front tube sheet, a figure somewhat lower than is ordinarily found in recent large boilers. The arrangement of the tubes in the sheet is shown in one of the illustrations; they are set with 13/16 in. bridges. The shell is made up of three cylindrical sheets, each of them ⅞ in. thick and varying from 89 3/16 in. to 106 9/16 in. in length. The front tube sheet is set some distance back into the first barrel sheet, making it 49½ in. back of the center line of the stack and giving a front end 85½ in. in length, a figure somewhat larger than the diameter of the front end.



CROSS SECTIONS THROUGH BOILER.

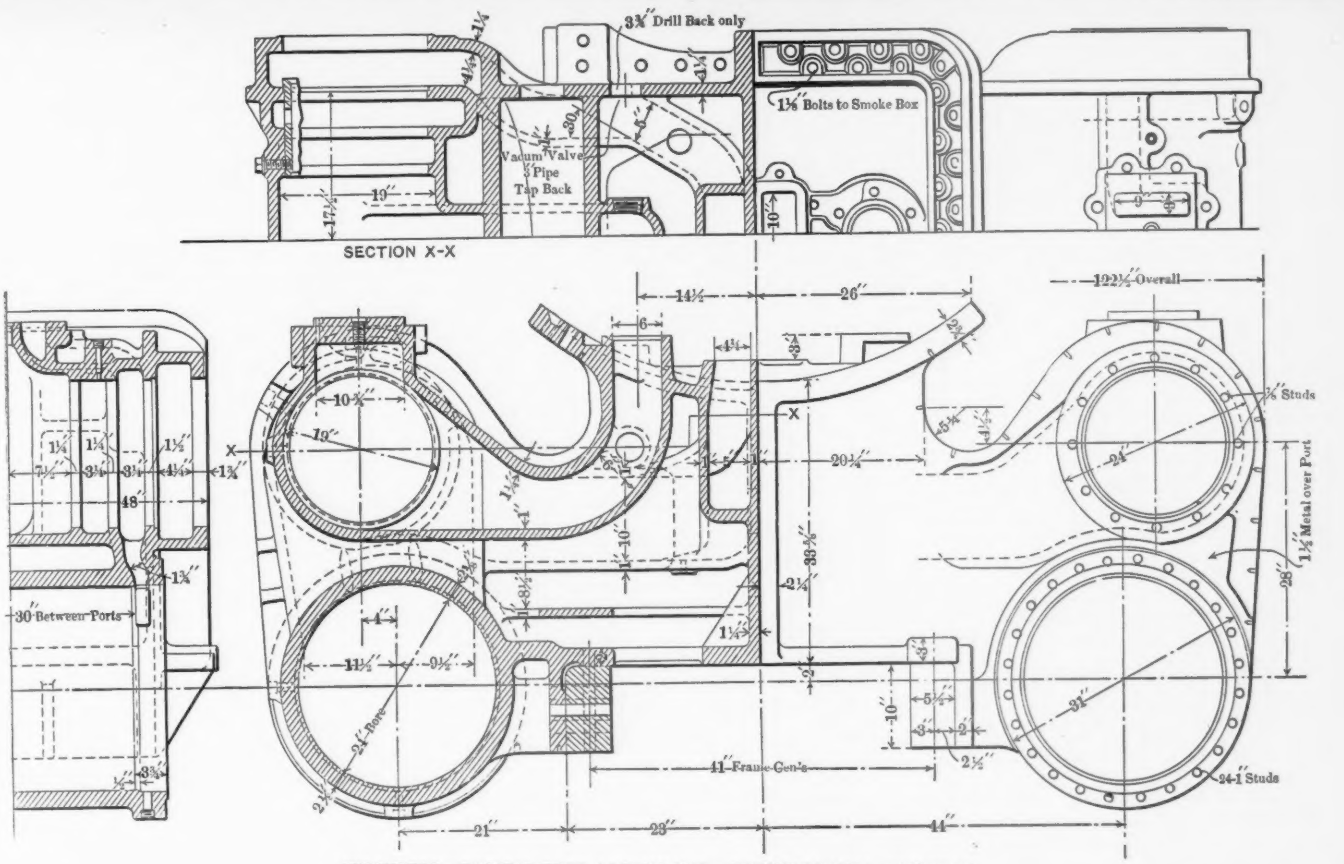
The grate area is 68.8 sq. ft., making it the largest grate of any passenger locomotive burning soft coal, on our records. The grate slopes forward, the front end being 14 in. lower than at the back and giving a throat over 23 in. in depth. The mud ring is 4½ in. wide on all sides, the water spaces being somewhat wider near the top. Both the outside and inside sheets slope inward due to the extreme width of 80¼ in. at the grate level. The crown stays are fitted with turnbuckles so that they can be adjusted and each will bear its proper share of the load. The injector feed is through an internal pipe, as has been the custom on the Pennsylvania Railroad for some time, this pipe coming from a double check valve chamber on the back head, and consisting of a 2¾ in. copper pipe, to a point just ahead of the crown sheet, where it is continued by a 2½ in. iron pipe to a discharge at about the water level near the front tube sheet. The grate is served by a single fire door 20 in. wide, set 22½ in. above the bottom of the mud ring, or slightly above the level of the bottom of the barrel.



HALF VIEW OF REAR HEAD AND SECTION THROUGH FIREBOX.

The boiler is supported on the frames by four plates between the cylinders and the fire-box and by a sliding support at the front end of the fire-box and a deep plate at the rear.

The placing of so large a boiler on a frame carried by 80 in. drivers has thrown it to such a height that it has been necessary to place the bell and the whistle off to one side of the center line and inclined diagonally outward so as not to exceed the clearance limits at these points. The stack is but 19½ in. high above the boiler, but is continued on the inside of the front



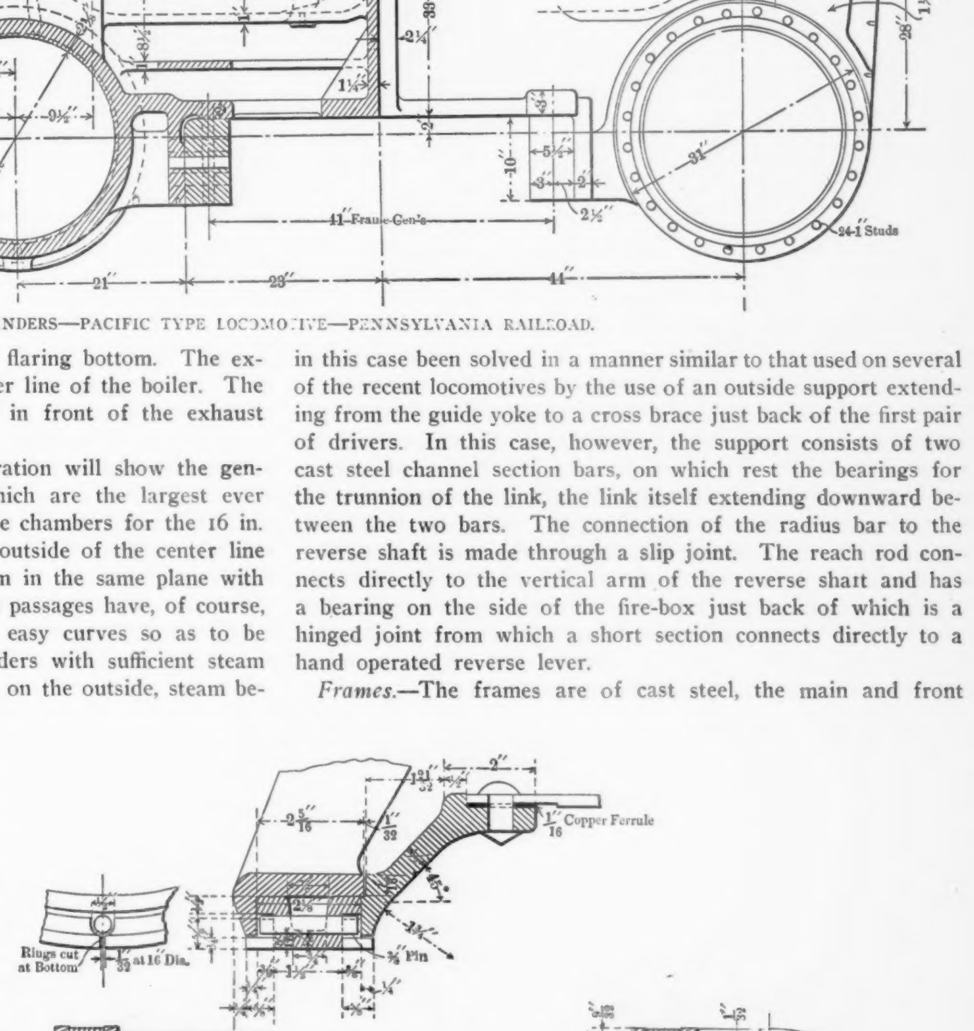
CYLINDERS—PACIFIC TYPE LOCOMOTIVE—PENNSYLVANIA RAILROAD.

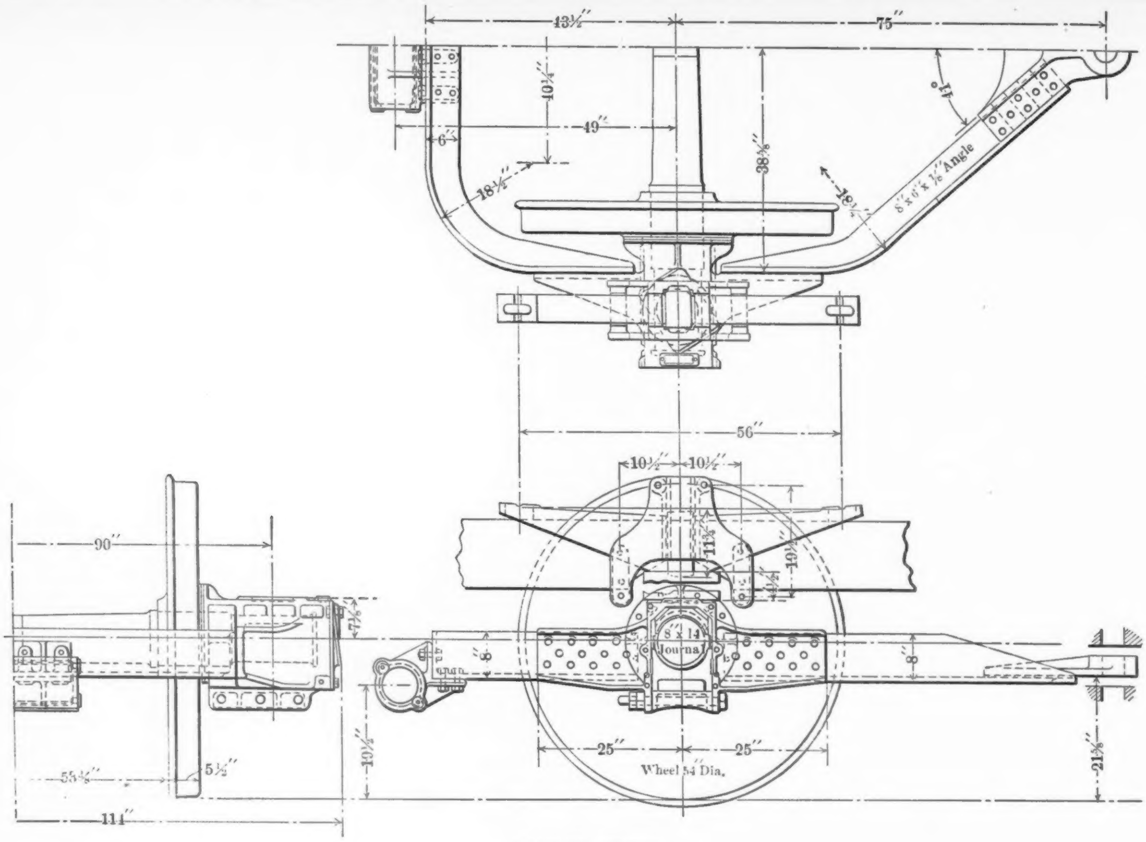
end by a draft pipe with a very large flaring bottom. The exhaust nozzle is 11⅛ in. below the center line of the boiler. The adjustable diaphragm plate is located in front of the exhaust nozzle.

Cylinders.—The accompanying illustration will show the general construction of the cylinders, which are the largest ever applied to a passenger locomotive. The chambers for the 16 in. piston valves have been thrown 4 in. outside of the center line of the cylinders in order to bring them in the same plane with the Walschaert valve gear. The steam passages have, of course, been made liberal and designed with easy curves so as to be able to furnish these very large cylinders with sufficient steam at high speed. The exhaust passage is on the outside, steam being admitted at the center of the valve chamber. The port leading from the valve chamber to the cylinders is almost straight and is 1¾ in. wide and 21 in. long where it enters the cylinder. These cylinders measure 122½ in. in width at the upper part of the valve chamber, making them wider than the bumper beam is long. They are, however, exceeded by one inch in width by the running board of the cab. The connections for relief valves, both vacuum and pressure, as well as for the lubricating pipes, are shown in the illustration.

Valves.—One of the illustrations shows a drawing of the 16 in. piston valves, which we believe are the largest piston valves ever applied to a locomotive. They have a travel of 7 in. and are made with 1 5/16 in. outside lap and ¼ in. inside clearance. They are set with a constant lead of ¼ in. The gear is of the Walschaert type and the difficulty of the location of the link with a locomotive having a four-wheel truck, has in this case been solved in a manner similar to that used on several of the recent locomotives by the use of an outside support extending from the guide yoke to a cross brace just back of the first pair of drivers. In this case, however, the support consists of two cast steel channel section bars, on which rest the bearings for the trunnion of the link, the link itself extending downward between the two bars. The connection of the radius bar to the reverse shaft is made through a slip joint. The reach rod connects directly to the vertical arm of the reverse shaft and has a bearing on the side of the fire-box just back of which is a hinged joint from which a short section connects directly to a hand operated reverse lever.

Frames.—The frames are of cast steel, the main and front



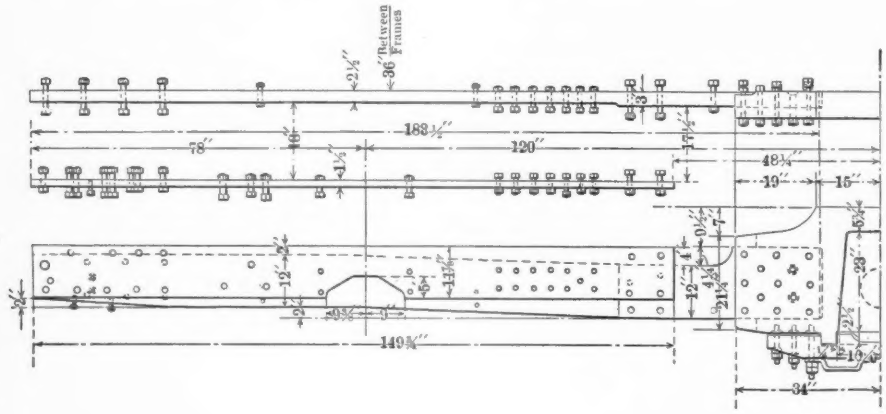


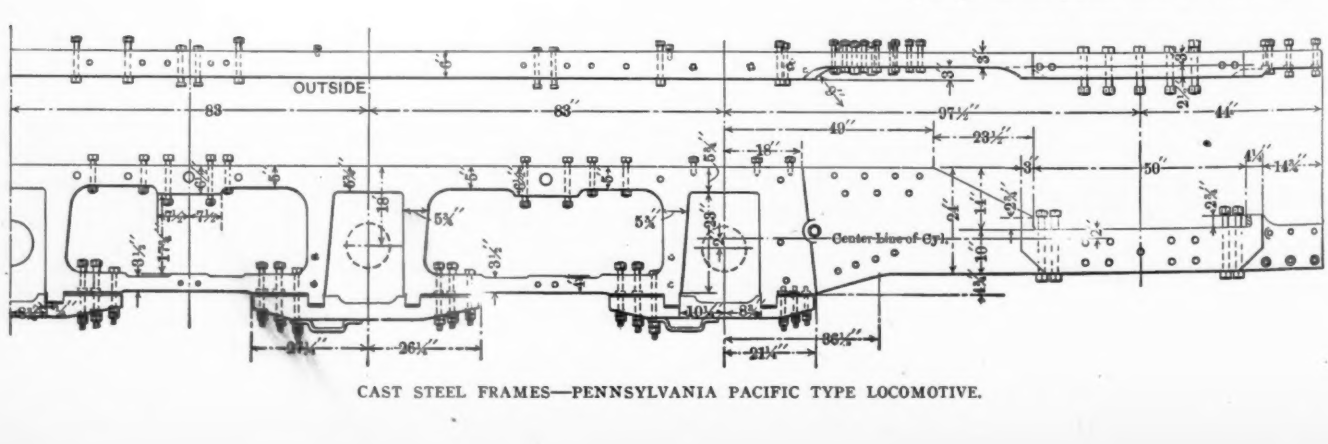
TRAILER TRUCK.

frame being in one section, which measures 6 in. in width and 5¾ in. deep at the pedestals and is 5½ x 10 in. in section below the cylinders. It assumes a plate form between the cylinders and the first driving pedestal where it is narrowed down to 3 in. in thickness and is 24 in. deep. This method gives flexibility at a point where difficulty is experienced with breakage in these very large and heavy frames. The trailer frame is in two parts, both being of plate design, the inner one being 2½ in. thick and the outer 1½ in. thick. These are spaced 18 in. apart and the trailing wheel comes between them. The inner one is securely bolted in a recess in the main frame and the outer one is secured by cast steel filling pieces at its ends.

Clip pedestal binders are used, being secured by three 1¼ in. bolts at either end. The fastening at the cylinders is by two 1⅜ in. vertical bolts front and back and by nine 1½ in. horizontal bolts. The frame bracing has been given careful attention and broad cast steel plates are secured between the upper rails at two points in the main frame, one being over the front pedestal and the other between the second and third pair of drivers. There are also several cross ties, binding the lower rails together, as well as the heavy cross bar at the front end of the fire-box.

Trailer Truck.—The accompanying illustration shows the details of the radial type of trailer truck which has been applied to this locomotive; it consists of a frame hinged at the forward end and secured by a spring centering device in the rear. The journal boxes are secured to this frame. On top of the boxes are caps arranged with grooves for rollers, the center line of the rollers being radial to the movement of the truck. Above the rollers is a cap or spring seat having similar grooves on its lower surface. The Y-shaped pieces spanning the springs act as guides and prevent any side





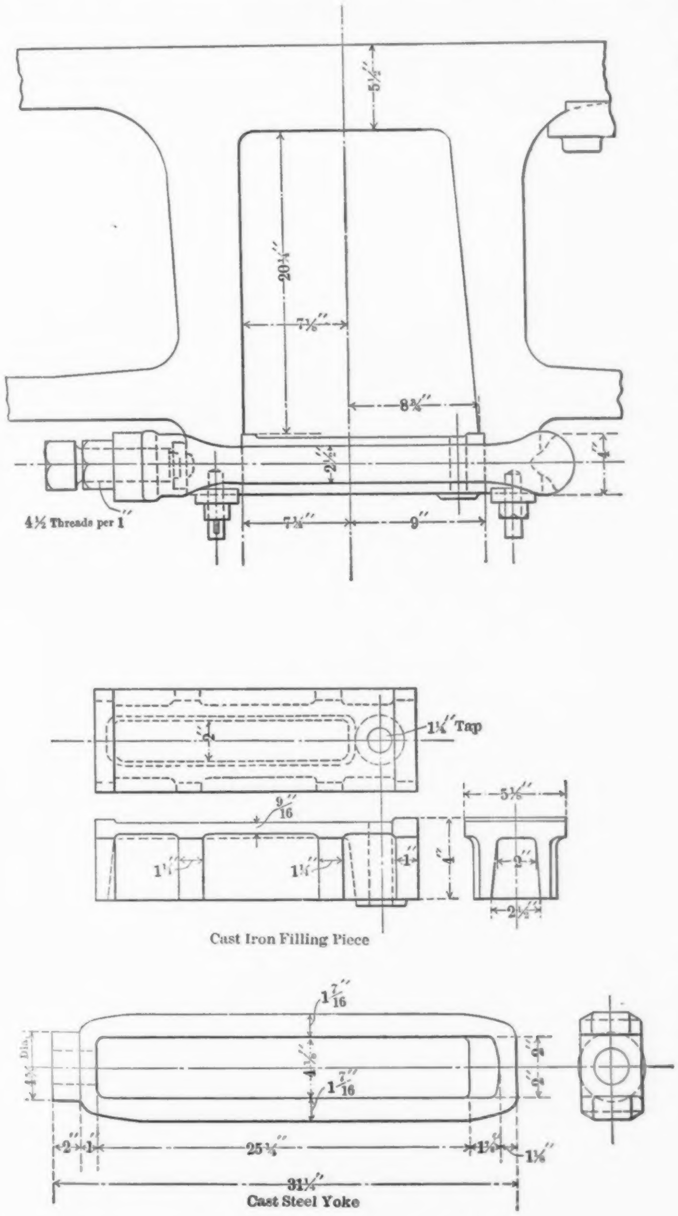
CAST STEEL FRAMES—PENNSYLVANIA PACIFIC TYPE LOCOMOTIVE.

motion of the spring or cap. The spring centering device is illustrated in the cross section of the locomotive shown on page 266 of the July issue of this journal.

The equalizing system is continued for the three drivers and trailer truck on each side of the locomotive. The springs are mounted above the frames over the boxes in every case and are secured to an equalizer located between the frame rails by hangers spanning the frames. Connection to the trailing truck is made by a long equalizer set diagonally so as to connect to the outside spring of the trailer and to the back of the spring over the rear driver, the front hanger being inside the frames.

NEW DESIGN OF PEDESTAL BINDER.

On an order of six 10-wheel passenger locomotives recently finished at the Baldwin Locomotive Works for the New York, Chicago & St. Louis Railroad, is found an interesting design of pedestal binder, which is shown in the accompanying illustra-



NEW DESIGN OF PEDESTAL BINDERS.

tion. These locomotives have 20 x 26 in. cylinders, 72 in. drivers and weigh about 156,350 lbs.

The binder consists of two principal parts, one being a cast iron filling block fitted between the jaws of the pedestal in a similar manner to that used with the large bolt type of binder. In this case, however, instead of a single large bolt passing through the jaws with its accompanying weakness at the sides of the holes, a cast steel yoke is provided which spans the pedestal jaws and the filling piece and is fitted with a 2¼ in. set screw on one end operating against a seat having a nub which fits in a recess in the outside of the jaw. A lock nut is provided on the set screw. Provision is also made for preventing the yoke from falling to the track in case the set screw becomes loosened by two clips or stops secured to the bottom of the jaw.

The cast iron filling piece is carefully designed to give lightness and the cast steel yoke is given a section at its weakest point of 1 7/16 x 2½ in., making it practically immune from breakage. Provision is made for a wedge adjusting screw.

A REGENERATIVE REVERSE PLANING MACHINE.

Under this caption the *Engineer* (London) describes an interesting planer recently brought out by Joshua Buckton & Company, Leeds, England. Recoil springs are placed near the back of the machine which are capable of absorbing the energy of the parts that move and have to be reversed, and restore, during acceleration, the energy that would otherwise be wasted. "Screws pass through these springs, and lie along the whole length of the bed. Adjustable on these screws are heavy bronze nuts, and against these nuts impinge knockers, attached in fixed position. The stroke can be adjusted while the machine is running, and the alteration in the position of the nuts does not disturb the synchronism of the belt striking motion with the spring compression."

"It will be understood that while the return stroke of the machine takes place at the constant speed of 180 ft. per minute, the cutting stroke can be varied through change-speed gearing, but although the total range of speed which gives the slowest cutting speed of 20 ft. and highest return speed of 180 ft. is in the ratio of 9 to 1, yet no adjustments are required between the highest and the slowest speed, and there is no difference in the accuracy of the line of reversal."

Ammeter diagrams, which are reproduced, indicate that the amount of power required at reversal is only slightly greater than while cutting, and in some cases is even less. An illustration of some of the work which was done on the machine shows a remarkable accuracy of reversal.

DECAPOD PUSHING LOCOMOTIVES.—The six locomotives of the 2-10-0 type recently delivered to the Buffalo, Rochester and Pittsburg Railroad by the American Locomotive Co. are in service between Clarion Junction and Freeman, Pa. At this point there is a ruling grade for north-bound trains of 58 ft. to the mile, with numerous curves, the sharpest of which are 8 degrees. Heretofore 3350 tons have been handled up this grade with two consolidation locomotives, each with a tractive effort of 38,000 pounds, one being used at the rear end as a pusher. The rating of one of the same locomotives from Punxutawney, Ernest or DuBois to the foot of the grade is 3,500 tons. With track improvements which are now in progress, it is expected that with the same class of consolidation engine it will be possible to handle 4,000 tons to the foot of the Clarion hill from either Punxutawney, Ernest or DuBois, and the decapod engines have been ordered in anticipation of these track improvements, and are expected to handle a train of 4,000 tons up Clarion hill with a consolidation at the head. These locomotives were illustrated in this journal in April, 1907, page 132, and May, 1907, page 188. They have 24 x 28 in. cylinders, 52 in. drivers, 80 in. boiler carrying 210 lbs. of steam and a tractive effort of 55,350 lbs.

WHAT RAILROADS HAVE DONE.—Did you ever stop to think that Omaha, or even Denver, is to-day, thanks to this railroad service, nearer to New York City than Philadelphia was in 1764, when Benjamin Franklin amused himself for three and a half days knitting stockings in a stage coach while going from the Quaker City to New York to sail to the other side in connection with some diplomatic service at the Court of St. James.—*From Mr. Deems' presidential address, Master Mechanics' Association.*

HEAVY ELECTRIC TRACTION ON THE NEW YORK, NEW HAVEN AND HARTFORD RAILWAY.

By E. H. McHenry, Vice-President.

The Act of Legislature of May 7, 1903, of the State of New York, providing for the future regulation of the terminals and approaches thereto of the New York & Harlem Railroad in the City of New York, authorizes the New York Central & Hudson River Railroad Company and the New York, New Haven & Hartford Railroad Company, lessees of the New York & Harlem Railroad Company, "to run their trains by electricity, or by compressed air, or by any motive power other than steam which does not involve combustion in the motors themselves" through the tunnel and over the tracks more specifically described. The Act requires that the change of motive power be made on or before July 1, 1908, and provides a penalty of $500 per day on and after that date for failure to comply with its terms. As there was no available form of motive power other than electricity which met the conditions of the Act, it accordingly became necessary for the N. Y. C. & H. R. R. R. and the N. Y., N. H. & H. R. R. to provide suitable engines, power houses, and track equipment for electrically operating all trains between the Grand Central Station at Forty-second Street and the prescribed sub-limits within the limits of the City of New York.

The terminal tracks of the New York & Harlem Railroad, between the Grand Central Station and the junction point at Woodlawn, a distance of twelve miles, are jointly leased and operated by both the Central and New Haven companies. The zone of electric operation on the lines of the latter was further extended twenty-one miles, to Stamford, to include the greater number of its suburban trains.

This feature of joint operation more than all others restricted and narrowed the latitude of choice in the selection of a system of electric traction by the New Haven Company. The Central Company was first in the field, and having previously adopted a system based on the use of continuous current motors taking current from a third rail, it was obvious that no method inconsistent with such conditions was open to the New Haven Company, and it was thus practically confined to a choice between a continuous current low voltage system as adopted by the Central Company and a more recently perfected high tension single phase system. The first has been in general use for a number of years and, as installed by the Central Company, includes the generation of alternating current at 11,000 volts and 25 cycles, high tension transmission to substations located approximately five miles apart, at which points it is reduced and transformed by static and rotary transformers to low tension continuous current at 666 volts. This current is supplied to the engine contact shoes through a secondary system of distributing feeders and an inverted third rail of improved type. Continuity and regularity of operation are further insured by a large and most noteworthy installation of storage batteries in each substation.

The single phase system is the latest and most advanced step in the evolution of electric traction, and it was not until 1904 that the first commercial installation, on the Cincinnati and Indianapolis Traction Company, was operated. With this system, electric power may be generated, transmitted, and supplied directly to the electric locomotive, substantially at the initial frequency and voltage, without intermediate reductions or transformations of any kind. In effect it duplicates the simplicity of the local street railway operating with continuous currents supplied directly to the motors from the trolley line. It avoids all necessity for the ordinary equipment of static and rotary transformers, storage batteries, low tension switchboards, and low tension distributing and contact conductors, while affording the flexibility and economy of high tension A. C. transmission over long distances.

The single phase motor, as its name implies, operates with single phase currents, and its characteristics are essentially identical with those of the more familiar continuous current series motors. Single phase motors are adapted for operating with either alternating or continuous currents, and this valuable feature makes it possible to design locomotives which may be operated at will by high tension alternating currents from an overhead conductor, or low tension continuous currents from a third rail.

The New Haven Company was one of the earliest pioneers in the field of heavy electric traction, and has operated six of its shorter branch lines by electricity in commercial service for a number of years past, beginning as early as 1895. Three of these lines, aggregating thirty-three miles in length, were equipped for overhead contact, and the remaining lines, aggregating thirty-nine and one-half miles in length, for a third rail contact. All lines were operated with 500 volt continuous current motors, supplied from main stations and substations of the familiar type. The third rail was rather primitive in form and without protective devices of any sort. So many fatalities and injuries followed the use of this method of supplying current to the motors that the railroad company was compelled to abandon all third rail operation in Connecticut and revert to steam service, by a decree of the Superior Court dated June 13, 1906, and it now has no third rail in service excepting a junction overlap with the New York Central road at Woodlawn. Improved methods of protecting the third rail were available which would have considerably mitigated the more dangerous features of the earlier installations, but the unfortunate and unsatisfactory experience of the railroad company with this type of construction influenced its decision in favor of the single phase system, which was finally adopted after a careful and complete investigation of the relative merits and disadvantages of the two methods of construction.

Had the study of the question been limited to the equipment of the terminal section in New York City, considerations of uniformity and expediency would doubtless have influenced the decision in favor of continuous current motors, taking current from a third rail. The New Haven Company, however, recognized the great importance of its decision in its far-reaching effect upon future extensions of electric service to other parts of its system, and the final decision was based upon a study of the subject as a whole rather than upon the solution of the terminal problem only.

The distinguishing characteristic of electric traction as contrasted with that of steam driven locomotives is in the condition that the motive power is utilized at variable and varying distances from the point of generation, and the selection of a system of transmission best adapted to such conditions, which combines in greatest measure qualities of efficiency, flexibility, simplicity, and lowest first cost, is of paramount importance. A glance at the map shows that the New Haven system comprises a network of lines and indicates that its transmission problems must be worked out for areas rather than for linear distances, thus reversing ordinary conditions.

As the area served increases as the *square* of the radius of transmission from the generating center, and as there may be many circuits in the network which will serve as paths to common points of use, it is evident that ordinary methods of calculation will be greatly modified. Under such conditions the economic radius corresponding to any initial potential will be considerably extended, and the commercial and practical value of high potential transmission will be much increased.

While both methods under consideration included high tension transmission by alternating current, it was believed that the combination method requiring transforming devices and continuous current motors was less well adapted to the conditions than its simpler single phase competitor for many reasons. The electric efficiency of the combination system between power house busbars and engine shoes is 75 per cent. only, as compared with 95 per cent. for the single phase system. The flexibility of the former is impaired by the limited radius of the secondary low tension distribution, requiring substations at frequent intervals, and still further by the limitations imposed by the use of a third or conductor rail. The position and height of this rail in its proper relation to the track rail must be rigidly maintained, and the practical margin of permissible variation is measured in fractions of an inch. Also, its continuity is broken at switches and crossings by frequent transferrence of the conductor rail to

the opposite side of the track or to an overhead position. In contrast, the single phase system requires no substations or secondary circuits; the continuity of the overhead conductor is complete, and its position and height may vary within vertical and horizontal limits of eight feet and four feet, respectively, without losing contact with the collecting shoes on the pantagraph frames.

It is yet too early to furnish definite and positive comparisons of cost of the two methods under consideration, but the calculations and experience of the railroad company's engineers indicate that the total cost of a single phase installation will be much less than that of the continuous current system, and that the higher electrical efficiency, lower fixed charges, maintenance, and operating expenses of the single phase system all tend to reduce the relative cost of current delivered to the engine shoes in about the same proportion.

The determination of the most economical and desirable frequency and voltage of the transmission system involved the consideration of many factors entering into the problem. The choice of frequency was practically fixed by the manufacturing companies within limits of fifteen and twenty-five cycles, and the comparative merits of these two rates only were considered.

The lower frequency afforded a material reduction in weight, size and cost of motors, a reduction in conductor losses and induction disturbances, together with an increase in the power factor of the motors. Per contra, its adoption would have materially impaired the commercial value of the system as a whole, in restricting or preventing its extension for many other uses incidental to railway operation. The standard power and railway frequency in general use is twenty-five cycles, and as the New Haven Company already owned a number of power houses generating current at this frequency for standard trolley operation, and, in addition, had equipped many of its shops with twenty-five cycle motors, the adoption of fifteen cycles would have required the abandonment of a large amount of standard apparatus, or the interposition of costly and inefficient means of translation. The lighting of stations and other buildings was quite an important factor, as 25 cycles is the lowest frequency at which the carbon filament lamps in general use can be satisfactorily operated. It was also considered desirable to provide for operation in parallel with the 25 cycle generators already adopted by the New York Central Company. The practical effect of a change from 25 to 15 cycle apparatus was thus substantially equivalent to a "break in gauge," and under existing conditions it was decided that the practical commercial value of the higher frequency outweighed the more theoretical merits of the lower one.

Various alternatives were considered before fixing the generating and transmission *e. m. f.* of the system. It was at first proposed to increase the economical radius of transmission to the utmost by generating current at the highest initial voltage for which generators could be safely designed (about 22,000 volts) and to provide substations at suitable intervals, equipped with static transformers, for supplying current at 3,000-6,000 volts to secondary contact circuits. As the two motors in each electric locomotive truck are permanently connected in series, current must be supplied at 560 volts through the transformer forming a part of the locomotive's equipment.

It became evident, however, that a great gain in simplicity would result if the intermediate substations and line transformers could be cut out altogether, and further study demonstrated the possibility of effecting this by reducing the initial *e. m. f.* to 11,000 volts and raising the ratio of the locomotive transformer to correspond. This was carried into effect with a resulting reduction in capital and operating cost, coupled with an increase of electrical efficiency, which proved most gratifying. Incidentally, the difficulties in designing satisfactory collecting devices were greatly diminished.

The difficult and responsible task of determining and analyzing operating conditions and requirements was assigned to Mr. Calvert Townley, consulting engineer, and Mr. William S. Murray, electrical engineer, of the New Haven Company, to whom, together with their able assistants, credit is due for the design, supervision and successful execution of the many and difficult details of this novel installation.

The Commercial Aspect.

A few comments upon the commercial aspects of electric traction may not prove uninteresting, as the natural prejudice of the stockholder in favor of the continued maintenance of dividends must be respected, and the technical expert too frequently neglects this aspect in his scientific ardor for the building of monuments of engineering skill and achievement.

Numerous analyses and comparisons of the comparative costs of electric and steam operation have been published from time to time, which tend to prove that a considerable saving in fuel, engine repairs and other operating expenses may be expected. Under favorable conditions this saving may be large enough to pay interest and other fixed charges upon the additional construction investment and still leave a satisfactory margin to apply on dividends. Under general conditions, however, it is altogether improbable that the direct saving resulting from the simple substitution of electric for steam power will be sufficient to justify the additional investment and financial risk.

In changing the method of motive power on existing railways, the conditions are by no means so simple as in the construction of new lines, as in the former case a great amount of capital already invested must be sacrificed, and the problems of adaptation to existing conditions are peculiarly severe. In particular, the transition stage in bridging over the gap between steam and electric operation is both expensive and difficult, as the change affects train lighting and heating, telegraph and telephone service, signaling, and track maintenance, for which both temporary and permanent provision must be made. The simultaneous maintenance of facilities and working forces for both steam and electric service within the same limits will be rarely profitable, for the reason that a large proportion of expenses incident to both kinds of service is retained without realizing the full economy of either.

To secure the fullest economy it is necessary to at least extend the new service over the whole length of the existing engine stage or district, and to include both passenger and freight trains, and in this connection it is interesting to note that in the case of the New Haven Company the passenger train mileage forms so large a proportion of the whole that no additional generating and transmission capacity will be needed when electric traction is extended to freight service.

The application of electric traction to heavy railway service will probably be governed by other and more important considerations than its mere relative cost as a motive power under similar conditions, as illustrated in the development of the ordinary trolley service. In this development the commercial value of higher speeds and of increased car capacity is so large that the relative cost of electric versus animal tractive power becomes almost negligible by comparison. Analogous results may be hoped for in the corresponding development of electric traction in heavy railway service, as the new conditions will afford opportunities for at least two radical modifications of existing conditions, quite apart from minor economies.

In steam service the weight and speed of trains are limited by the horse power capacity of the locomotive, which generates its own power, and there are but few locomotives which can generate sufficient steam to utilize their full cylinder tractive power at speeds in excess of twelve miles an hour. Consequently, any increase of speed beyond certain limits can only be attained by sacrificing train tonnage in a corresponding degree. The division of the train mile cost by the lesser number of tons increases the ton mile cost proportionately.

The high cost of fast freight service is principally due to this effect of a diminishing divisor, while it would seem that electric traction should permit high speeds without sacrificing commercial tonnage, as, with a relatively unlimited source of power at command, the maximum drawbar pull permitted by the motor design, may be maintained at all speeds.

The commercial value of high speed in freight and passenger

service is so great that the prospect of escaping the present penalties accompanying reduced train capacity becomes doubly interesting.

Hardly less important is the opportunity afforded at the opposite end of the scale, for the economical operation of trains of *minimum* capacity. The train capacity cannot be reduced without loss, below the point where the earnings equal the train mile cost, and if this cost cannot be reduced proportionately with reduced capacity, the inferior limit of capacity may be uneconomically large. In steam service the irreducible elements entering into the train mile cost are so large that it is rarely profitable to operate trains earning less than forty to fifty cents per mile. In contrast, electric service permits an extreme reduction of the train length to single car units, costing to operate but ten to fifteen cents per car mile. Hence, the frequency of service may be increased and rates reduced, which in turn will react upon the volume of traffic, with the final result of increasing both gross and net earnings. It may, therefore, be claimed for electric traction that it will extend the limits of profitable operation of high speed heavy trains, and also of light trains of low capacity.

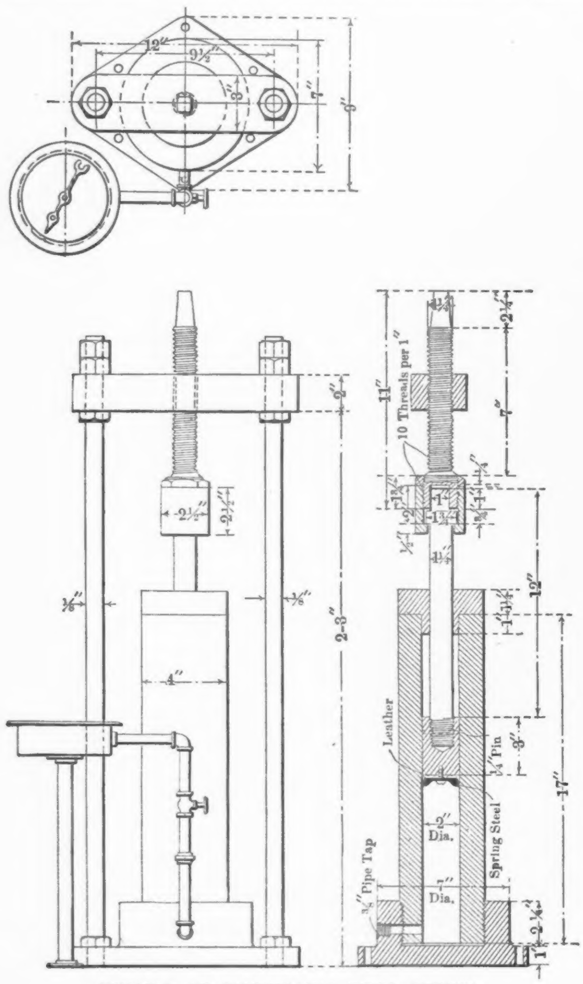
Other but relatively minor advantages are possible in the effect upon earnings, due to the elimination of smoke, gases, dust, cinders, and heat, the better ventilation of cars, the extension of electric train lighting and heating; and of the effect upon expenses due to the concentration of power production in large and economical power houses, a reduction of engine repairs, an increase of effective engine and train mileage, a more or less complete elimination of engine houses, turntables, fuel stations, water tanks, cinder pits, and other operating facilities, the consolidation of power requirements for traction, pumping, operating shops, elevators, and general uses, and the use of current for lighting switch lamps, stations and other buildings.

Finally, the availability and value of real estate and structures at large terminals will be greatly augmented by the possibilities of using two or more superimposed track levels, as strikingly exemplified in the plans for new terminals in New York City for the New York Central and the Pennsylvania Companies.

A general change from steam to electricity will render unproductive a very large amount of invested capital, and create the necessity for the expenditure of additional amounts still greater, but there is no reason to doubt that the transition already in progress will be rapidly extended and applied at all points where congested terminals, high frequency of train service and low cost of power create favorable conditions.

PNEUMATIC DRILL TESTER.

A unique pneumatic drill tester is in use in the tool room of the McKees Rocks shops of the Pittsburgh & Lake Erie Railroad. The drawing shows the construction of this device and the photograph shows it with a drill in position for making a test. The cylinder is 2 ins. in diameter, and is partially filled with oil. The pneumatic drill drives the screw, which forces the piston in

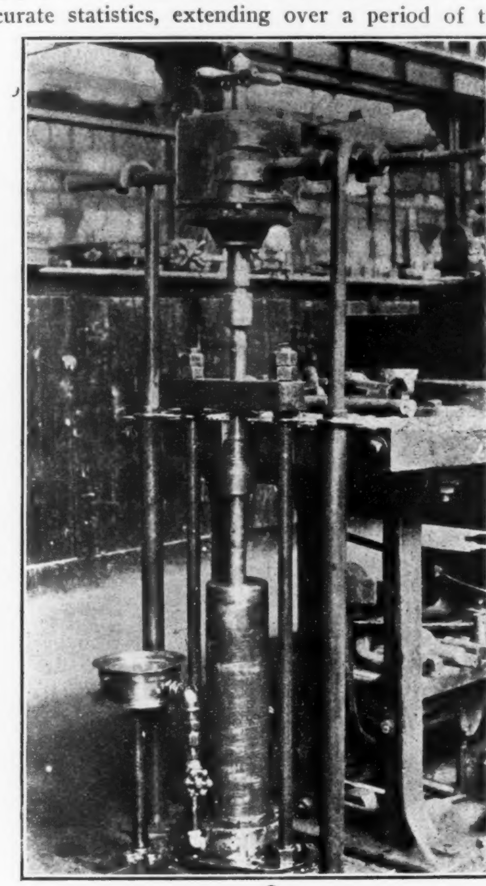


DETAILS OF PNEUMATIC DRILL TESTER.

the cylinder downward. The recording gauge, which has a capacity of 6000 lbs., records the pressure in the cylinder and the capacity of the drill is determined by the pressure at which it is stalled. Different makes of drills, guaranteed to be of the same power, have shown a variation on this test of from 1800 to 5500 pounds.

When a new drill is received at the shop it is tested and a record made of its capacity. When the drill requires repairs or any complaint is made as to its not doing the work properly, it is tested to determine whether its capacity has fallen off, and after it is repaired it is again tested to make sure it has been restored to its original capacity.

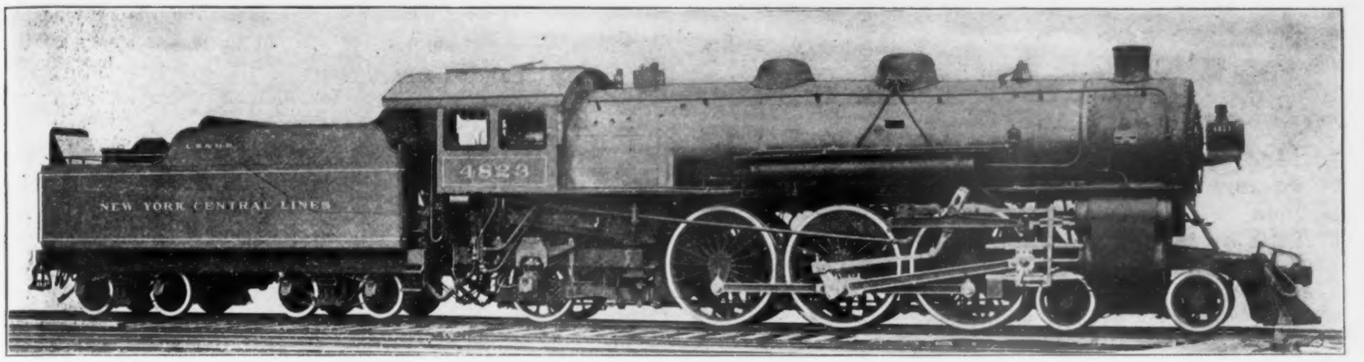
Fuel Consumption of Gasoline Motor Cars.—Mr. W. R. McKeen, Jr., in a communication to *The Railroad Gazette*, states that accurate statistics, extending over a period of two years,



PNEUMATIC DRILL TESTER IN OPERATION.

show that the Union Pacific motor cars are being operated at a cost of $3.36 per 100 miles for fuel.

Motor Driven Machine Tools.—It is said that 70 per cent. of the output of machine tools by the Niles-Bement-Pond Company are driven by individual motors, and that the same condition obtains for 50 per cent. of the products handled by Manning, Maxwell & Moore.—*Power.*



PACIFIC TYPE PASSENGER LOCOMOTIVE.

LAKE SHORE & MICHIGAN SOUTHERN RAILWAY.

The Prairie type locomotive for passenger service has found its most extensive and general use on the Lake Shore & Michigan Southern Railway, where for the past six years it has been the favorite type for heavy high speed trains. The first locomotive of this type was introduced on that railroad in 1901, and weighed 174,500 lbs. This was followed three years later by a new design of the same type, which weighed 233,000 lbs., and at that time was the heaviest passenger locomotive in the world. In 1906 another design was brought out, which weighed 244,700 lbs., again being the heaviest passenger locomotive in the world. The next step in this development of passenger locomotives on this railway changes from the Prairie to the Pacific type, which are now being delivered by the American Locomotive Company. This step was taken to conform to the New York Central Lines standards. The standard modern passenger engine of that system at the present time is the 21 x 26 in. Atlantic type and the Pacific type is, in its wheel arrangement, simply an enlargement of the Atlantic type. These locomotives have the distinction of being next to the heaviest ever built ,being exceeded only by the one recently built for the Pennsylvania Railroad, which was illustrated on page 267 of the July issue of this journal.

The accompanying tabie traces the passenger locomotive development on this railway through the five different designs from the 10-wheel type used in 1899 to this last order, which includes 25 locomotives. The most noticeable feature in this comparison is the large increase of boiler capacity, the B. D. factor having steadily decreased from 648 to 550. The cylinders at the same time have increased from 20 x 28 to 22 x 28 in., the steam pressure and size of drivers meanwhile remaining practically the same. It will be noticed that the Pacific type engines have but little more weight on drivers than the latest design of Prairie type, although the cylinder is ½ in. larger in diameter and the tractive effort correspondingly increased. The factor of adhesion, however, is ample. The introduction of the four-wheel truck has permitted the installing of a heavier boiler without increasing the weight on drivers and at the same time giving the advantage of the better guiding qualities of this type of truck without reducing the pulling power of the locomotive.

DEVELOPMENT OF PASSENGER LOCOMOTIVES, L. S. & M. S. RY.

Type	4-6-0	2-6-2	2-6-2	2-6-2	4-6-2
Year built	1899	1901	1904	1906	1907
Total weight, lbs.	171,800	174,500	233,000	244,700	261,500
Weight on drivers, lbs.	133,000	130,000	166,000	170,000	170,700
Tractive effort, lbs.	24,990	25,200	27,850	27,850	29,200
Size cylinders	20″ × 28″	20½″ × 28″	21½″ × 28″	21½″ × 28″	22″ × 28″
Steam pressure, lbs.	210	200	200	200	200
Diam. drivers	80″	80″	79″	79″	79″
Total heat. surf., sq. ft.	2917.	3343.	3905.	3905.	4195.
Tube heat. surf., sq. ft.	2694.	3169.	3678.	3678.	3961.
No. and diam. of tubes.	345–2	285–2¼	322–2¼	322–2¼	379–2
Length of tubes	15′ ¼″	19′	19′ 6″	19′ 6″	20′
Grate area, sq. ft.	33.6	48.5	55.	55.	56.3
Diameter of boiler	66″	66″	70″	70″	72″
Total wgt. ÷ total H. S.	59.5	52.3	59.8	62.5	62.2
Wt. drivers ÷ total H. S.	45.6	39.0	42.5	43.6	40.8
Total H. S. ÷ grate area	87.0	68.8	71.0	71.0	74.3
B. D. factor	684.	605.	563.	563.	550.
Total H. S. ÷ vol. of cyls.	286.	314.	332.	332.	345.
Refer. in AMER. ENG.	'99-344	'01-71	'04-413	'06-203	

These locomotives are very similar to the one built for the Pennsylvania Railroad, mentioned above. They employ the same general arrangement of Walschaert valve gear, in which the link is hung on a steel casting supported outside the front driving wheel; also the same design and arrangement of radial trailer truck.

The boilers are of the radial stay type with conical connection sheet, the outside diameter of the front ring being 72 in. Three of the boilers are fitted with combustion chambers, and in these the front tube sheet has been moved ahead sufficient to give a length of tubes of 18 ft. or only 2 ft. shorter than the tubes in the engines without combustion chambers. The chamber itself is 4 ft. long. The boilers without combustion chambers contain 379-2 in. tubes, and those with combustion chambers 332-2 in. tubes. While this decreases the amount of total heating surface considerably it is believed from the experience of the Northern Pacific Railway that the capacity of the boiler will not be materially decreased by the installation of the combustion chamber. The chamber is radially stayed to the shell on the bottom and sides, and has expansion stays on the upper section. Ample water space of 8½ in. at the bottom and 7 in. at the closest point at the sides is provided. The smaller number of flues in the boilers with the combustion chambers is due to the fact that the outer shell of all the boilers is alike, so that when new fireboxes are required combustion chambers can either be applied or removed. On the previous order of Prairie type locomotive 2¼ in. tubes were specified, but it was found that better service could be obtaned from 2 in. tubes without detriment to the steaming qualities of the boiler, and this size has therefore been used on the new engines.

The locomotives are furnished with 79 in. wheels, but the machinery parts are arranged so that 69 in. wheels may be applied where it is required to operate over divisions having considerable grade. The cylinders are designed so that when 69 in. wheels are used they can bored to 24 in.

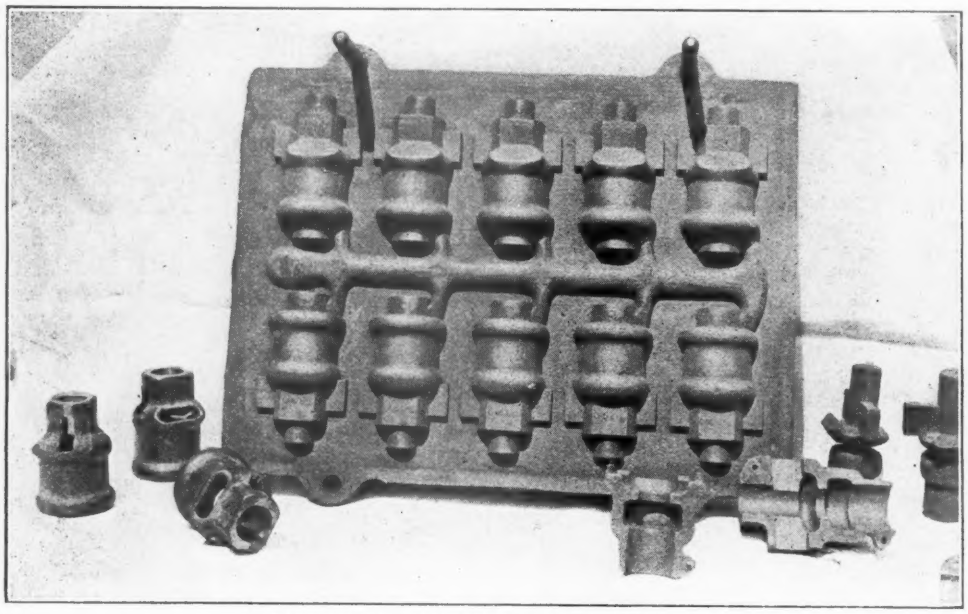
The general dimensions, weights and ratios of both designs of locomotives are given in the table below:

	Without Comb. Chamber.	With Comb. Chamber.
GENERAL DATA.		
Service	Passenger	Passenger
Fuel	Bit. Coal	Bit. Coal
Tractive effort	29,200 lbs.	29,200 lbs.
Weight in working order	261,500 lbs.	261,500 lbs.
Weight on drivers	170,700 lbs.	167,000 lbs.
Weight of engine and tender in working order	423,700 lbs.	423,700 lbs.
Wheel base, driving	14 ft.	14 ft.
Wheel base, total	36 ft. 6 in.	36 ft. 6 in.
Wheel base, engine and tender	67 ft. 10¼ in.	67 ft 10¼ in.
RATIOS.		
Weight on drivers ÷ tractive effort	5.83	5.72
Total weight ÷ tractive effort	9.03	9.03
Tractive effort × diam. drivers ÷ heating surface	550.00	675.00
Total heating surface ÷ grate area	74.50	60.50
Firebox heat. surface ÷ total heat. surface, per cent.	4.92	8.62
Weight on drivers ÷ total heating surface	40.60	48.90
Total weight ÷ total heating surface	62.40	76.70
Volume both cylinders, cu. ft.	12.35	12.35
Total heating surface ÷ vol. cylinders.	340.00	276.00
Grate area ÷ vol. cylinders	4.58	4.58
CYLINDERS.		
Kind	Simple	Simple
Diameter and stroke	22 in. × 28 in.	22 × 28 in.
VALVES.		
Kind	Piston	Piston
Greatest travel	6 in.	6 in.
Outside lap	1 1/16 in.	1 1/16 in.
Inside clearance	1/16 in.	1/16 in.
Lead in full gear	¼ in.	¼ in.
WHEELS.		
Driving, diameter over tires	79 in.	79 in.
Driving, thickness of tires	72 in.	72 in.
Driving journals, main, diameter and length	10½ × 12 in.	10½ × 12 in.
Driving journals, others, diam. and length	10½ × 12 in.	10½ × 12 in.

Engine truck wheels, diameter	36 in.	36 in.
Engine truck, journals	6½ × 12 in.	6½ × 12 in.
Trailing truck wheels, diameter	50¼ in.	50¼ in.
Trailing truck, journals	8 × 14 in.	8 × 14 in.
BOILER.		
Style	Conical	Conical
Working pressure	200 lbs.	200 lbs.
Outside diameter of first ring	71 15/16 in.	71 15/16 in.
Firebox, length and width	108½ ×75¼ in.	108½ × 75¼ in.
Firebox plates, thickness	⅜ and ½ in.	⅜ and ½ in.
Firebox, water space	4½ in.	4½ in.
Tubes, number and outside diam	379—2 in.	332—2 in.
Tubes, length	20 ft.	18 ft.
Heating surface, tubes	3,960.6 sq. ft.	3,112.5 sq. ft.
Heating surface, firebox	206.0 sq. ft.	268.4 sq. ft.
Heating surface, total	4,195.0 sq. ft.	3,409.3 sq. ft.
Grate area	56.3 sq. ft.	56.3 sq. ft.
Smokestack, diameter	18 and 20 in.	18 and 20 in.
Smokestack, height above rail	14 ft. 7⅞ in.	14 ft. 7⅞ in.
TENDER.		
Tank	Water Bottom	———
Frame	13 in. Chan.....	13 in. Chan.
Wheels, diameter	36 in.	36 in.
Journals, diameter and length	5½ × 10 in.	5½ × 10 in.
Water capacity	8,000 gals.	8,000 gals.
Coal capacity	14 tons	14 tons

A GOOD IDEA IN PATTERN MAKING.

The method of moulding the standard Lake Shore cylinder cocks at the Collinwood shops is worthy of note. The pattern is mounted on one side of the plate only, as shown in the illustration, but is so arranged that the drag and cope of the flask are rammed from the same plate without changing. This idea is in very general use in connection with the patterns for the brass foundry at the Collinwood shops and simplifies the matter of pattern making and moulding so much that it is surprising that it is not followed to a greater extent in other shops, as it has a very wide range of application. The pattern shown is used in connection with a Berkshire moulding machine. The core box and cores are shown to the right and the finished casting to the left, in the illustration.



PATTERN FOR MOULDING CYLINDER COCKS.

SIDE DOOR SUBURBAN PASSENGER CARS.

In a report on transit facilities prepared by the City Club of New York and addressed to the Public Service Commission the Illinois Central type of side door car is discussed as follows:

"The Illinois Central Railroad, with the heaviest suburban traffic in this country, operates cars of 100 seats, with 12 doors on each side. The seats face one another in pairs, and a door is placed between each pair of seats. The maximum stopping time of a train composed of these cars is conditioned only by the time that it requires eight people to pass out and eight to enter, eight being the number served by one door. In practical operation these trains stop on an average but 7.07 seconds. Owing to the fact that the guard who closes all the doors of a car stands at one side of the car, so that he can look along the whole length of both the outside and inside of the car, very few accidents occur. Mr. W. D. Dunning, an official of the road, made the following statement in a letter written to the secretary of the City Club:

"'The side-door cars have been in daily use since 1903, and during the three years of their service under my direct charge and as a result of my intimate experience with these cars, I can unhesitatingly say they are a success in every phase of the service in which they are used, and I believe they fully meet every requirement of a dense passenger traffic under conditions where quickness of operation is an essential requisite. The cars each seat 100 passengers, and have standing room for a large number in addition, without interfering with rapid entrance and exit. No difficulties have been found in their operation, the perfect control of the side doors by the trainmen preventing passengers from getting on or off the cars while in motion. The doors work freely, with but little effort, and no trouble has been experienced in keeping the cars warm during the coldest weather. The time saved in their use, over the end-door type, is more noticeable during the hours of heavy travel, and has resulted in the average stop being reduced from 30 seconds to 7 seconds. All of the side-door cars are framed throughout of steel and were built new at the company's shops. None of the old cars were reconstructed. No platform men are required with the side-door cars, the doors being operated from within the cars by the regular trainmen. As to the accidents to passengers with the side-door cars, I have consulted with our claim department officials, and the conclusion is reached that the use of the side doors has reduced the number of accidents about 90 per cent. In fact, with the exception of an occasional slight mishap, the element of personal injury has been well nigh eliminated.'"

To use this type of car in the New York Subway some special provision will have to be made for stations on curves, but this can undoubtedly be taken care of. It is estimated that the introduction of this type of car would increase the total possible seating capacity per hour of the Subway, during rush hours, from 18,876 to 56,000.

Traffic in New York City.—The total number of passengers handled by the elevated, surface and subway lines of New York, in round numbers, was 670,000,000 in 1902, 765,000,000 in 1903, 814,000,000 in 1904, 816,000,000 in 1905, and 1,007,000,000 in 1906. The increase in 1906 over 1905 was 146,200,000, or 14 per cent., which is the greatest gain recorded both in volume and percentage.

Development of Ocean Liners.—The accompany table, taken from *Engineering* (London) for August 2nd, and presented in connection with a very complete detail description of the Cunard turbine-driven quadruple-screw Atlantic liner Lusitania, presents in a compact form the development in capacity and efficiency of ocean liners since the advent of the first Cunard liner.

	"Britannia," 1840.	"Persia," 1856.	"Gallia," 1879.	"Umbria," 1884.	"Campania," 1893.	"Lusitania," 1907.
Coal necessary to steam to New York .. .. .. tons	570	1400	836	1,900	2,900	5,000 *
Cargo carried .. .. .. "	224	750	1700	1,000	1,620	1,500
Passengers	115	250	320	1,225	1,700	2,198
Indicated horse-power ..	710	3600	5000	14,500	30,000	68,000
Steam Pressure .. .. lbs	9	33	75	100	165	200
Coal per indicated horse-power per hour .. .. lbs	5.1	3.8	1.9	1.9	1.6	1.45 *
Speed .. .. knots	8.5	13.1	15.5	19	22	25

* Estimated.

THE MAXIMUS BRAKE.

It is well known that the coefficient of friction between the brake shoe and the wheel, and hence the retarding effect of the brake, is very materially less at high speeds than it is just before the wheel comes to rest. This condition caused the adoption in this country several years ago of the high speed brake for heavy passenger trains, which, by increasing the pressure in the brake cylinder upon the application of the brake and gradually reducing it by allowing the excess to leak off through a reducing valve, the final pressure being the same as for the ordinary quick action brake, has resulted in decreasing the length of stop about 30 per cent. from speeds of 50 miles per hour and upwards.

The change from the quick action to the high speed brake requires no alteration, other than some strengthening, in the foundation brake gear. There is in use, however, in England and

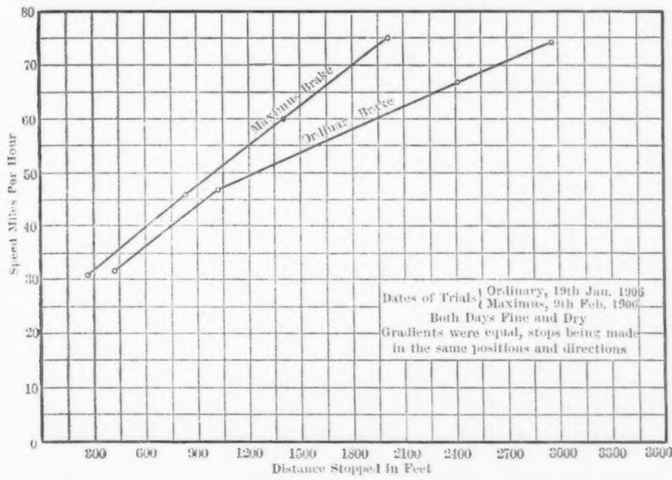
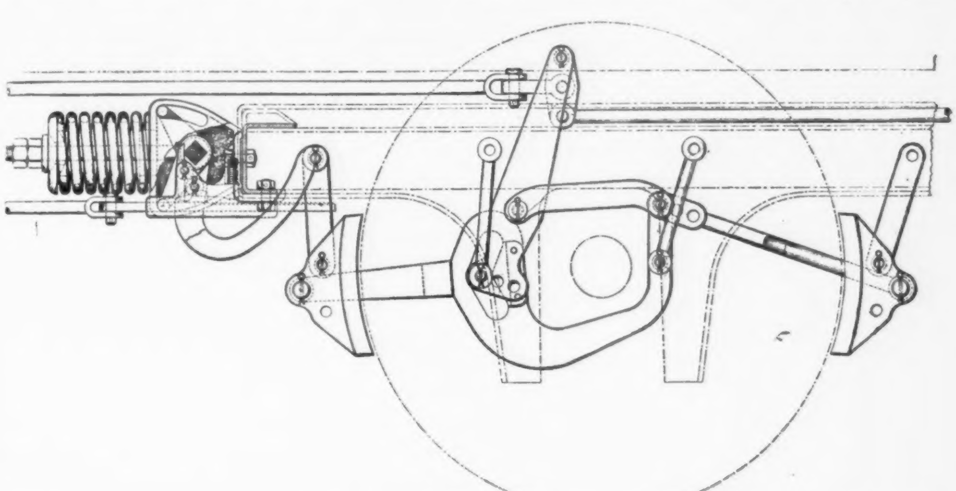


DIAGRAM OF BRAKE TRIALS ON THE NORTH-EASTERN RAILWAY.

on the Continent an arrangement of the foundation brake gear which automatically performs the same functions as the high speed brake with the further advantage that it also automatically adjusts the intensity of its action to the speed at which the train is running when the brake is applied. This brake is known as the Maximus and the results of some tests recently made on the North-Eastern Railway of England are shown by the curves in one of the illustrations. These tests represent stops made from different speeds with a single coach, braked on four of its six wheels to 62 per cent. of its weight with the ordinary brake. The tests were made with the same coach on the same line under similar conditions and indicate very clearly the advantage of the Maximus brake over the ordinary for high speed trains.

The arrangement of the device is shown in the illustrations, and while it is here illustrated as including two brake shoes, the principles are equally applicable where one brake shoe is used. The shoe is suspended by a link hung from a bell crank which is rigidly fastened to a square rod reaching across the end of the truck. To this shaft are also fastened two short lever arms, which have pins at the end fitting in radial slots in the casting bolted to the end piece of the truck. This casting also forms a seat for a spiral spring, the stem of which is attached to the square shaft. At the center of the shaft and fastened to the truck frame is a fitting which supports a ratchet slide having a pivoted tooth pawl held in the disengaged position by the shaft when the brake shoe is in its normal position on the wheel. The ratchet slide is connected by a rod to the end of the cylinder or floating lever and the teeth are arranged to permit the brake to be released, but will prevent any further application after the pawl is dropped into place. The connection between the truck lever and the brake beam is made through a roller on the lever which works in a V-shaped cam slot in the yoke connecting to the brake beam.



MAXIMUS BRAKE APPLIED TO A FOUR-WHEEL TRUCK.

The action of the brake is as follows: The coil spring is tightened up, by means of a follower plate and nuts on the end of its stem, to give a tension which will hold the brake shoe in its normal position under a certain predetermined coefficient of friction.

By means of a larger cylinder, higher pressure, or change in leverage, the brakes being applied at high speed are given a brake shoe pressure which equals 160 per cent. of the weight of the cars. At high speeds this will not produce a coefficient of friction sufficiently great to overcome the resistance of the spring and hence the apparatus remains in its normal position. When the speed of the train is sufficiently slackened to increase the coefficient of friction then the action of the brake shoe pulling on the bell crank compresses the spring, slightly moves the square shaft inward and downward (or upward), thus releasing the pawl, which engages the ratchet slide and prevents the cylinder pressure from following up the shoe. As this takes place the shoe in moving downward alters the position of the roller on the truck lever in the V-shaped slot, so as to move the shoe away from the wheel and thus reduce the pressure. In this manner the shoe maintains a position on the wheel that corresponds to the coefficient of friction for which the coil springs are originally set, since a reduction in the friction will permit the spring to again raise the shoe and draw it tighter against the wheel by the change in the connection to the truck lever.

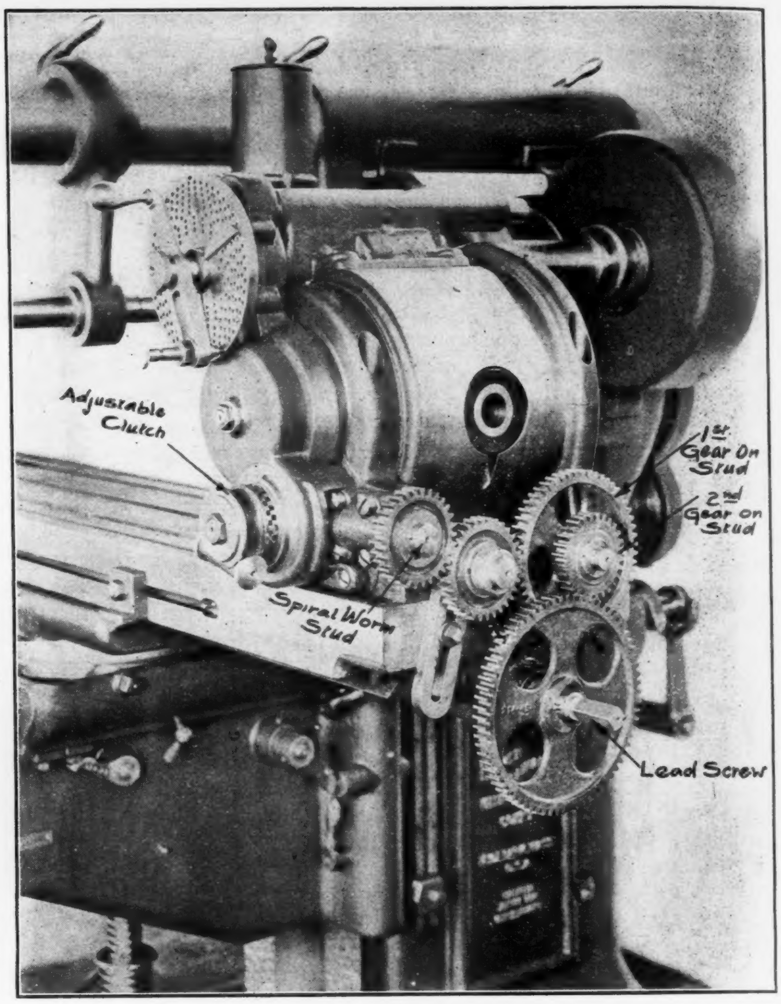
This apparatus is controlled by the Maximus Brake Syndicate, Queen Ann's Chambers, Westminster, London, and is being introduced in this country by Mr. Harvey E. Brown, managing director of the company, whose headquarters at present are at the Southern Hotel, St. Louis, Mo.

COST OF BLOCK SIGNALS.—Some idea of the enormous cost of equipping a railroad with block signals may be gained from reports just compiled by the Pennsylvania Railroad. Out of a total mileage on the Company's Eastern Lines of 6,032, more than fifteen hundred additional miles have within the last three years been equipped with block signals, at a cost of $856,520.36 to the railroad company, and adding $210,816.05 to the annual operating expenses. The report shows that the Pennsylvania Company now has every mile of its main lines protected by block signals, and of the entire mileage of the Lines East but about 500 miles are not so equipped; most of this, however, consists of short, industrial lines or branch lines on which the traffic is so light and of such a character as to render the block signal unnecessary.

During 1906 there were 86 old locomotives sold and 43 scrapped on the Pennsylvania Railroad proper.

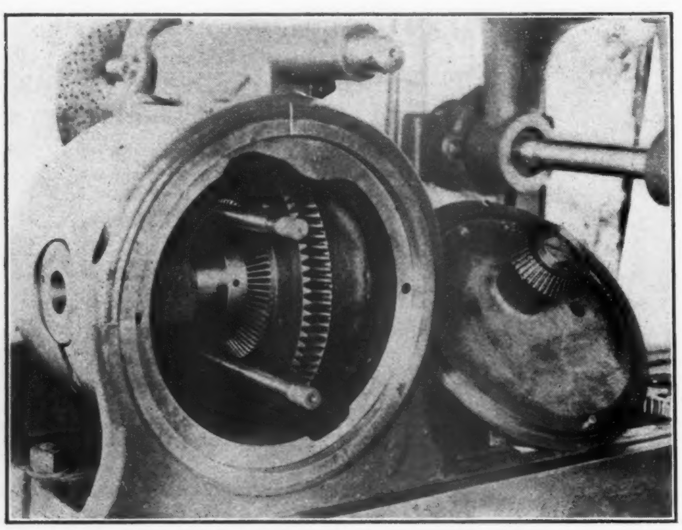
NEW UNIVERSAL INDEX AND SPIRAL HEAD FOR MILLING MACHINES.

A new universal index and spiral head has been designed by the Becker-Brainard Milling Machine Company, of Hyde Park, Mass., to meet the need of a spiral head that will answer the requirements of the heavier duty now imposed on milling machines and still retain the accuracy and at the same time meet the requirements of the wide range of work met with in ordinary practice, without sacrificing any of the desirable features of the older heads, and to add such features as will increase the usefulness of the head in general work. The accompanying illustrations show the various features of this new design. The increase in the strength of the head has not interfered with the ease of handling, nor made the head at all clumsy or awkward to operate. The design is of an approved type, having the swivel block housed between heavy uprights in which the block swings in a vertical plane. The block is held in any position by means of clamping bolts which draw the outside plates securely against the uprights, holding the head in position against the heaviest cuts.



The worm gear is made in two sections to insure accuracy in the hobbing of the teeth and in the adjusting for wear. An important feature of the design is the fact that the worm gear has been made as large as the swing of the different size heads will allow. The view showing the back head removed gives a good idea of the comparatively large diameter of the dividing wheel. This not only adds materially to the life of the wheel, but insures greater accuracy in the work than is possible with a smaller diameter, such as is ordinarily used. The large diameter and the coarse pitch of the teeth makes it possible to take heavier spiral cuts without any risk of impairing the accuracy or of distorting the teeth in the gear. The increase in the strength of the head throughout makes it possible to take heavier cuts at faster feeds and speeds and thus to utilize the high speed steels to greater advantage.

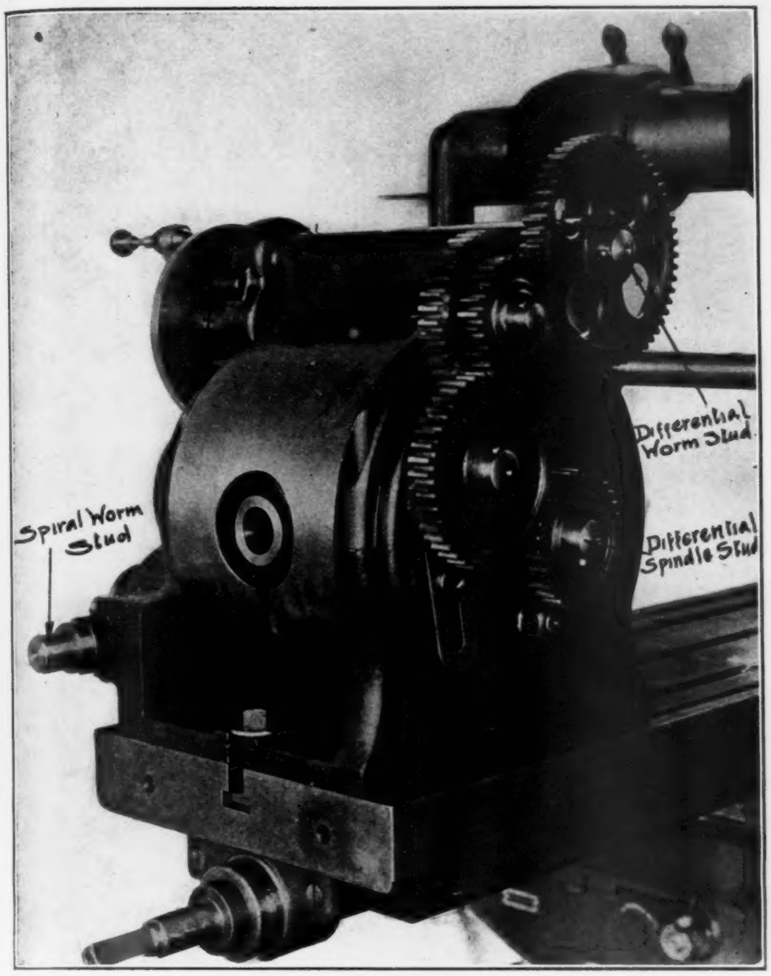
The idea of making the differential mechanism a component part of the head has been carried out so that the head may be used as an index or dividing head in any position along the platen, with the spindle either parallel with or at right angles to the main spindle of the machine, or in any intermediate position. This has been accomplished by placing the change gears, used in differential indexing, on the rear side of the head, as shown in the view where the gears are set in position. The gears have no connection with the table. With the gears used in differential indexing arranged on the head, it is possible to swing the spindle into position for cutting bevel gears or teeth on any conical work. This at once broadens the scope of differential indexing from cylindrical work to that which requires the angular setting of the spindle in the vertical plane.



SHOWING COMPARATIVE SIZE OF WORM WHEEL.

In order that the application of the differential indexing may be universal, it is necessary that it be made available for use on work with helical or spiral grooves, such as spiral gears. This has been accomplished in the following manner: The principle, on which the differential system of indexing works, makes it necessary to have the spindle and index plate so connected by means of change gearing that the movement of the spindle will cause a movement of the index plate in one direction or the other, as the case may be. This makes it necessary for the index plate to be free to move on its axis, independent of the index crank during the indexing operation. In cutting spirals the plate is geared to the lead screw by suitable change gears. The connection between the lead screw and the index plate must be broken when making division, in order that the index plate may be free to make the differential movement with the index crank. This breaking of the connection is accomplished by means of an adjustable clutch which is withdrawn during the indexing operation. After the division has been made, the teeth in the clutch will be found to be in such a position, in relation to the corresponding spaces, that it is impossible to engage them. In order to bring the teeth and spaces opposite each other, one-half of the clutch is made adjustable so that it may be rotated the required amount to bring the two portions in proper position for engagement. This adjustment is accomplished by means of the knurled knobs attached to the clutch. The connection between the index crank through the worm, worm gear, spindle and change gears of the differential indexing mechanism and the index plate, when the index pin is in mesh with a hole in the plate, would form a locked train, which must be released during the spiral cutting operation. This release is accomplished by means of the knurled knob back of the index plate, which operates a friction clutch.

Frequently it is desired to roll the work a small amount on its axis without shifting the dog or losing the position of the index pin, or the amount of roll over may be such that, should



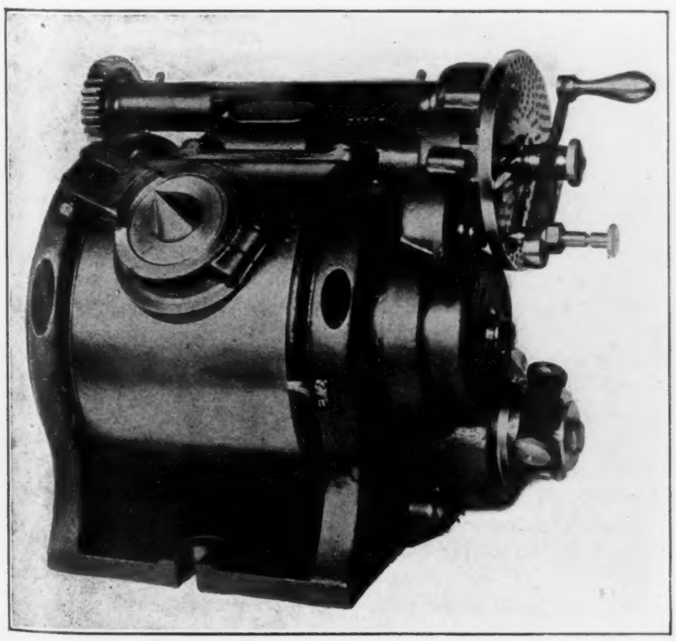
tage to be gained in doing away with the back pin and substituting the more flexible holding device.

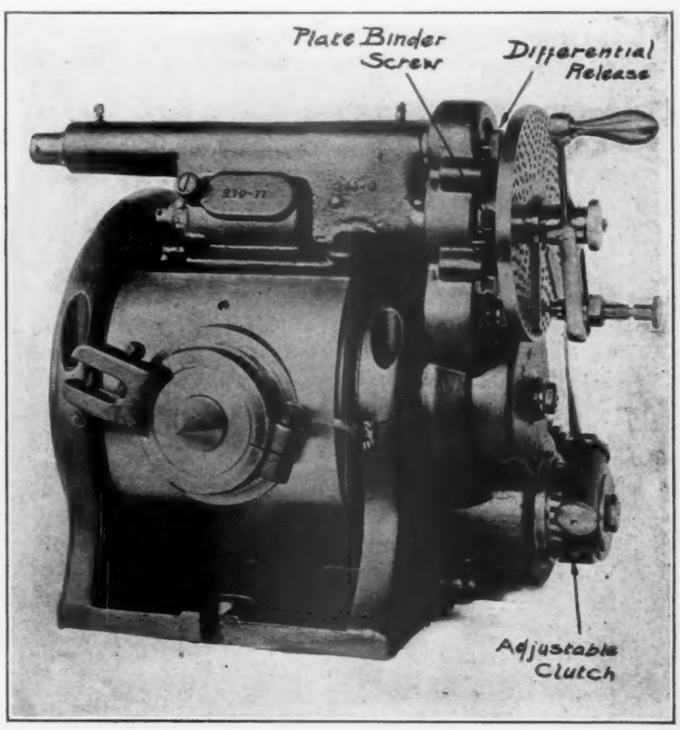
In work requiring the head to be connected up for spiral cutting the roll over of the work is made more convenient by the presence of the adjustable clutch which, as explained above, allows the disconnection of the spiral cutting train so that the spindle and work may be revolved, or rolled over, without changing the position in relation to the cutter in a direction parallel with the feed motion.

THE DRY KILN requires steam heat at all seasons of the year, and as planing mills are usually placed at quite a distance from other buildings (on account of the fire risk) it is inconvenient to carry the shavings any great distance, as for instance to a power-house, which should ordinarily be located in the power center of gravity of the locomotive department. Shavings are always very difficult to dispose of, and yet they have a certain amount of value as fuel if properly utilized. Considering these various points, it has seemed to the writer as if the best solution of the problem would be to put a small boiler plant, consisting possibly of only one boiler, in a wing alongside the planing mill, and feed this automatically with the shavings. The steam generated can be used to operate the dry kiln, and in winter time also to heat the planing mill. For this purpose the ordinary run of shavings would no doubt be ample, although they do not make a desirable fuel for the regular power-house, and the small amount of attention which such a boiler would need, as no moving machinery is involved, would, we think, be generally preferable and cheaper than attempting to carry the shavings to the power-house (if located as above described) and steam heat back again to the planing mill and the dry kiln. The shavings can be blown, in such a case, directly into the furnace by means of a fan driven by an electric motor, and the labor required for operating the boiler would be very small.—*Mr. G. R. Henderson at the New England Railroad Club.*

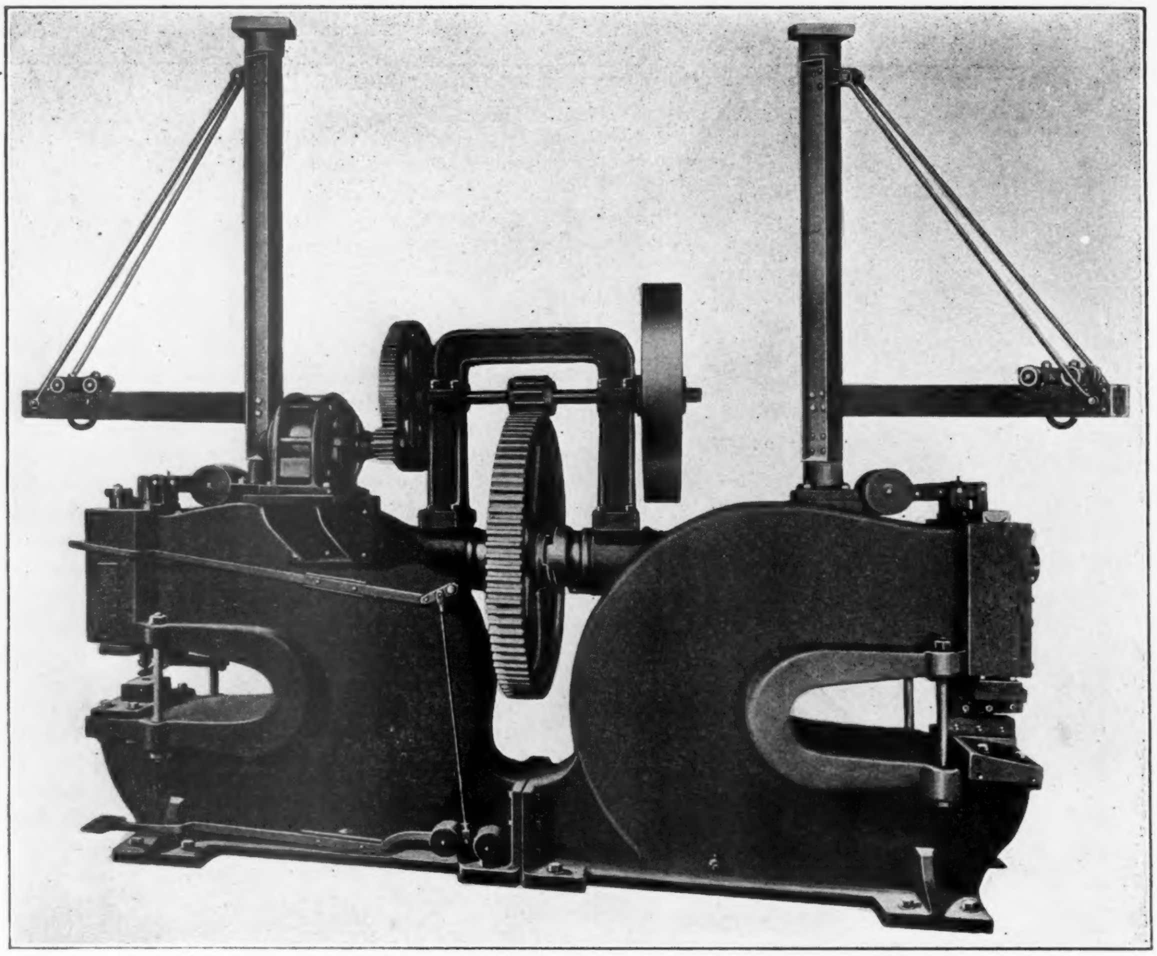
The Pennsylvania system uses between seven and eight million ties a year and during 1906 used nearly 160,000 tons of steel rails.

it be accomplished by rotating the crank, the pin would not come exactly over a hole. Should it be attempted to move both plate and crank in conjunction, it would be found that the back pin of the ordinary head would not engage with a back hole. In this head the back pin is done away with and the plate is held in position when resorting to plain indexing by a friction hold on the hub of the plate gear which is clamped or released by a suitable bolt conveniently located. By this means, work may be set regardless of the position of the plate and the plate can then be securely held in the position it takes when the work is so set. Those who have used the ordinary head will realize the advan-





NEW UNIVERSAL INDEX AND SPIRAL HEAD FOR MILLING MACHINES.



HEAVY DOUBLE 36-INCH CINCINNATI PUNCH.

HEAVY DOUBLE 36-INCH PUNCH.

The Chicago & Western Indiana Railway Company has recently installed a heavy double 36-inch punch at its Chicago shops, which weighs complete about 45,000 lbs., and was furnished by the Cincinnati Punch & Shear Company of Cincinnati. It is driven by a direct connected, 10 h.p., General Electric motor, as shown, and is equipped with two cranes having 9 ft. arms. The frames are of the double wall box type, making them very rigid; the heads are extra long. The machine is equipped with the patent positive adjustable stop, described on page 65 of our February, 1905, issue, which allows the machine to be automatically stopped at any desired part of the stroke, making it valuable for such work as accurate center punching. The sliding clutch is also of the Cincinnati Punch & Shear Company's well-known patent type, the section of the driving shaft upon which the clutch slides being square, thus doing away with the use of feathers and keys.

Automobile Horse-Power Formula.—The Association of Licensed Automobile Manufacturers has adopted the following formula for rating the horse-power of automobile engines:

$$H. P. = \frac{D^2 \times N}{2.5}$$

The *Horseless Age* recently published the following table based on this formula:

Bore of Cylinder, Inches.	Number of Cylinders. 1.	2.	3.	4.	6.
	Horse-power.				
3	3.6	7.2	10.8	14.4	21.6
3.25	4.2	8.4	12.7	16.9	25.3
3.50	4.9	9.8	14.7	19.6	29.4
3.75	5.6	11.2	16.9	22.5	33.7
4.	6.4	12.8	19.2	25.6	38.4
4.25	7.2	14.4	21.7	28.9	43.3
4.50	8.1	16.2	24.3	32.4	48.6
4.75	9.0	18.0	27.1	36.1	54.1
5.	10.0	20.0	30.0	40.0	60.0
5.25	11.0	22.0	33.1	44.1	66.1
5.50	12.1	24.2	36.3	48.4	72.6
5.75	13.2	26.4	39.7	52.9	79.3
6	14.4	28.8	43.2	57.6	86.4

Freight Car Efficiency.—When an intelligent citizen learns for the first time that the freight cars of the country make only 24 or 25 miles a day (The best figure that I know of for 1905 is 24.8. For the first six months of 1906 this rate was raised to 25.7.), he feels at once that something must be wrong and very wrong; but this is not necessarily the case. It is perhaps a pity that we have adopted a unit like this. Probably it would have been better to have said that our freight cars made 9,000 miles a year, or 9,500 miles a year. All of you would think it absurd that so and so's automobile only made 20 or 30 miles a day, when you knew it could make more than that in one hour; but when a man tells you he has run his automobile 9,000 miles in a year, he speaks as if he had made a pretty good record. Of course, no one expects an automobile to be running all the time. If it takes a run in the daytime, it probably does not take one at night. It has to be cleaned and it has to be repaired. Its owner needs rest and, sometimes, refreshment. Now, in just the same way there are a great many things which influence the rate of movement of a car. It has to be inspected, lubricated, repaired, loaded and unloaded. If it runs at night, it generally stands still all day and sometimes several days, and vice versa.

Now, a mile a day increase does not seem much to make, but its result is very material. An increase of one mile a day means an increase of 80,000 or 100,000 cars in this country, and that number of new cars would cost the railroads nearly $100,000,000; or, putting it in another way, an increase of one mile per day means an increase of 4 or 5 per cent. in the cars available for loading every day. My estimate is that the country loads about 150,000 cars a day, and this meagre increase of one mile means, therefore, an increase in the country of 6,000 or 7,000 carloads a day.—*Mr. Arthur Hale, General Supt. of Transportation, B. & O. R. R., before the Transportation Association of Milwaukee.*

At the close of the current year the Union and Southern Pacific Railways will have 4,700 miles of track protected by automatic block signals.

PERSONALS

Mr. C. B. Gray has been appointed assistant master mechanic of the Pennsylvania Railroad at Ormsby, Pa.

Mr. W. K. Christie has been appointed master mechanic of the Kalamazoo, Lake Shore & Chicago, with office at South Haven, Mich.

Mr. B. F. Elliott has been appointed assistant master car builder of the Mexican Central with headquarters at Aguascalientes, Mex.

Mr. M. M. Meyers has been appointed master mechanic of the Missouri Pacific, with headquarters at De Soto, Mo., succeeding Mr. A. S. Grant.

Mr. Leonard Ruhle has been appointed master mechanic of the Colorado & Northwestern, with office at Boulder, Colo., succeeding Mr. M. Fitzgerald.

Mr. R. P. C. Sanderson has resigned as superintendent of motive power of the Seaboard Air Line, to accept a similar position with the Virginian Railway.

Mr. F. C. Hudson has been appointed master mechanic of the Canadian Northern Quebec Railway Company, with headquarters at Shawinigan Junction, Que.

Mr. S. P. Spangler has been appointed master mechanic of the St. Louis, Watkins & Gulf, with office at Lake Charles, La., succeeding Mr. J. C. Ramsey, resigned.

Mr. H. W. Ridgway, master mechanic of the Colorado & Southern at Trinidad, Colo., has been transferred to Denver, Colo., in place of Mr. D. Patterson, resigned.

Mr. G. A. Baker has been appointed superintendent of motive power of the Santa Fe Central, with office at Estancia, N. M., succeeding Mr. T. J. Tonge, resigned.

Mr. W. L. Larry has resigned as division master mechanic of the New York, New Haven & Hartford to become an inspector for the Massachusetts railroad commission.

Mr. T. J. Tonge has resigned as superintendent of motive power of the Santa Fe Central to become connected with the El Paso & Southwestern at Santa Rosa, N. M.

Mr. P. Conniff, heretofore general foreman of the Baltimore & Ohio at Holloway, O., has been appointed master mechanic at Benwood, W. Va., succeeding Mr. F. C. Scott, resigned.

Mr. E. D. Andrews has been appointed master mechanic of the Sterling division of the Chicago, Burlington & Quincy, with headquarters at Sterling, Colo., vice Mr. F. Newton, resigned.

Mr. J. Dietrich has been appointed master mechanic of the Lincoln division of the Chicago, Burlington & Quincy, with headquarters at Lincoln, Neb., succeeding Mr. J. J. Buttery, who has been assigned to other duties.

Mr. M. A. Kinney, roundhouse foreman of the Baltimore & Ohio at Newark, O., has been appointed master mechanic of the Hocking Valley, with headquarters at Columbus, O., succeeding Mr. E. J. Powell, resigned.

Mr. M. J. La Court, foreman of the car department of the Chicago, Milwaukee & St .Paul at La Crosse, Wis., has been appointed general traveling inspector of cars for the entire Chicogo, Milwaukee & St. Paul system.

Mr. F. E. Doxey, heretofore foreman of shops of the Illinois Central at Waterloo, Ia., has been appointed master mechanic of the Des Moines, Iowa Falls & Northern, with headquarters at Iowa Falls, Ia., to succeed Mr. L. C. Rost, resigned.

Mr. A. S. Barrows, chief clerk to the second vice-president and general manager of the Buffalo & Susquehanna, has been appointed chief clerk to the general superintendent of motive power of the Rock Island Lines at Chicago.

Mr. George W. Wildin, assistant superintendent of motive power of the Lehigh Valley, has been appointed mechanical superintendent of the New York, New Haven & Hartford, with office at New Haven, Conn., to succeed Mr. F. T. Hyndman, resigned.

PROF. CHARLES HENRY BENJAMIN.—The appointment is announced of Professor Charles Henry Benjamin to be dean of the Schools of Engineering of Purdue University, to succeed Dean W. F. M. Goss, who resigns in order to accept a similar appointment at the University of Illinois. Professor Benjamin comes to Purdue from the chair of mechanical engineering at Case School of Applied Science, which he has occupied with distinction since 1889, prior to which time he was, for three years, engaged in engineering practice and, for six years, as instructor and professor of mechanical engineering in the University of Maine, of which institution he is a graduate. He brings an unusually successful experience and valuable equipment as teacher, investigator, author, and engineer, and will be recognized as a worthy occupant of the chair so long and eminently filled by Dr. Goss.

BOOKS

The Art of Cutting Metals, by Frederick W. Taylor, M.E., Sc.D. Presidential Address presented at the last annual meeting of The American Society of Mechanical Engineers. Cloth. Price, $3.00.

This or any other publication of the Society may be had by addressing the Secretary, 29 West 39th Street, New York. It is not necessary to send orders through members. None of the publications of The American Society of Mechanical Engineers are copyrighted.

Effect of Scale on the Transmission of Heat Through Locomotive Boiler Tubes. By Edward C. Schmidt and John Snodgrass. Bulletin No. 11, University of Illinois Engineering Experiment Station. Published by the University at Urbana, Ill.

This bulletin records the results of several series of tests, both on actual locomotives and on specially designed apparatus, to obtain information concerning the effect of scale on the transmission of heat through the tubes. Part of this information was recently included in a paper before the Western Railway Club by one of the authors. The bulletin includes reports of a number of earlier tests in addition to those given in that paper.

Universal Directory of Railway Officials. 1907. Compiled under the direction of Mr. S. Richardson Blundstone, Editor of *The Railway Engineer*. Published by The Directory Publishing Company, Limited, 3 Ludgate Circus Buildings, E. C., London. United States Representative, A. Fenton Walker, 143 Liberty street, New York City. Price, 10 shillings.

Presents information as to the length of road in operation, gauge, number of locomotives and passenger and freight cars, and a directory of the officials of all the railroads in the world. Practically all tramways worked by power in the United Kingdom are included. The book is splendidly indexed; there is an index to countries, one to the names of the railways and one to names of the officials. It is clearly printed and well bound.

PRODUCTION OF AUTOMOBILES.—According to a consular report, issued by the Washington Bureau for Manufactures, the United States in 1902 produced only 314 machines as compared with 24,000 which were built in France. The production of the various countries in 1906 was as follows: Germany, 22,000; United States, 58,000; France, 55,000; England, 27,000; Italy, 18,000; Belgium, 12,000.

CATALOGS.

Flange Unions.—The Western Tube Company, Kewanee, Ill., is issuing a leaflet illustrating and describing the Kewanee union flange, which is made of malleable iron, with the exception of the brass seat.

Something Cooling for a Hot Day.—This is the title of an attractive 16-page folder, Bulletin 90, recently issued by the B. F. Sturtevant Company. It describes various types of electric propeller fans and illustrates their application.

Rack-Rail Locomotives.—A. Borsig, Tegel, Germany, is issuing a pamphlet (No. 1157) illustrating some of the rack-rail locomotives recently completed at his works both for German and other railways. Many locomotives from these works are in use in the mountains of South America. The catalog briefly considers the type in general and discusses the capacities and limitations of a number of locomotives recently built.

Storage Batteries for Stationary Service.—The Westinghouse Machine Company is issuing an attractive catalog on this subject, which includes many illustrations and comprehensive descriptive matter of the latest designs of storage batteries. Details are included giving data and prices of the different sizes. Interesting curves are reproduced, showing the variations in capacity of storage batteries with the percentage rate of discharge, also with the rate of discharge in hours.

Air Compressors and Pneumatic Tools.—The Chicago Pneumatic Tool Company, Fisher Building, Chicago, is sending out two new catalogs. The first one, No. 23, contains over 100 pages and is devoted entirely to its Franklin air compressors. The second one, No. 24, is about the same size and covers the pneumatic tools and appliances, including Boyer and Keller hammers, Little Giant drills, sand rammers and hoists. Both of these publications are well indexed and strongly bound.

Rotary Snow Plow.—A pamphlet recently issued by the American Locomotive Company illustrates and describes the rotary snow plow built by that company. The first part of the pamphlet contains a brief account of the work done by the rotary in fighting the snow, with illustrations of it in operation. Then follows a description of the plow, considering the particular features of the design. The last part of the pamphlet contains a set of rules for the guidance of those operating this type of plow.

Six-Wheel Switching Locomotives.—The American Locomotive Company has just issued the ninth of its series of pamphlets covering the standard types of locomotives. As the title indicates, this number of the series is devoted to six-wheel switching locomotives and contains half-tone illustrations and the principal dimensions of twenty-six different designs of this type. The designs illustrated range in weights from 102,000 to 176,500 pounds, and are adapted to a variety of service conditions.

Thomson Polyphase Induction Wattmeters.—Bulletin No. 4527 issued by the General Electric Company, Schenectady, N. Y., describes the latest form of these meters, which are made for the specific purpose of measuring energy in any two-phase, three-phase or monocyclic circuit. They are made in three types; one for house service with metal cover, and two for switchboard use, one having a metal cover and the other a glass cover. The bulletin gives catalog numbers and capacities, etc., of the various sizes, and a large number of connection diagrams showing the method of installation on different classes of circuits.

Forcing Presses.—The Watson-Stillman Company of New York City is sending out catalog No. 70, which contains about 130 pages and is devoted entirely to forcing presses, or those tools and presses whose main purpose is the making or breaking of forced fits or for driving broaching tools and similar work. A large part of the catalog concerns new machines which have not been described in previous catalogs. Many of the tools are specially adapted for railroad shop conditions. In addition to the manufacture of its standard tools, this cimpany is in position to undertake the building of special machines to meet the needs of the purchaser.

Valves and Steam and Water Specialties.—A 60-page catalog, known as No. 9, has just been received from the Golden-Anderson Valve Specialty Company, Fulton Building, Pittsburg, Pa. The construction of the various devices manufactured by them is described and clearly illustrated. Among these various specialties are the Anderson cushioned non-return valves, Anderson reducing valves, "Clean Seat" valves, Anderson cushioned check and hand stop valve, Golden high and low pressure tilting steam trap, Anderson balanced plug cock, Anderson balanced plug locomotive blow-off, Anderson automatic and counter-balanced valve for standpipe and tank service, Anderson automatic standpipes, Anderson automatic track float valves, Anderson altitude valves and Anderson ideal strainer and fish traps.

Brass and Iron Steam Engineering Specialties.—A very complete 281-page catalog (No. 9) has just been prepared for distribution by The Wm. Powell Company, 2525 Spring Grove avenue, Cincinnati, Ohio. The construction and merits of each article are described in detail. The book is provided with a carefully prepared index and is divided into the following general divisions: "White Star" valves, "Model Star" valves, "Union" composite disc valves, hydraulic valves, iron body valves and flanges, throttle and gate valves, blow-off valves and swing check valves, injectors, standard miscellaneous valves, lubricators, gas engine trimmings, oilers and grease cups, staple boiler and engine trimmings, and revolving chucks. An appendix of 18 pages contains a series of tables and rules giving, in a concise form, information required by engineers and shop managers.

Grinding Wheels and Machinery.—The Norton Company, Worcester, Mass., is issuing a new edition of its catalog which supersedes all previous issues. This has 146 pages, is printed on heavy paper and includes a large number of excellent illustrations of grinding machines and grinding wheels of all shapes and sizes. These wheels are made of alundum, which is said to be the hardest, sharpest and most durable abrasive material known. The catalog briefly describes the method of manufacture of the wheels, gives rules for calculating proper speeds or diameters, as well as tables of rim speeds for different revolutions per minute, etc. Dimensioned line drawings are given of a large variety of special wheels suitable for different makes of grinding machinery and for the different classes of special work. A section of the catalog is devoted to a discussion of oil stones manufactured by this company The latter half of the book includes illustrations and descriptions of a large variety of grinding machines.

Balanced Compound Locomotive.—The Baldwin Locomotive Works is issuing Record No. 62 on the subject of balanced compound locomotives. It contains a large number of half-tone illustrations and line drawings of this type of locomotive, as well as a discussion of the merits of the type and a description of some of the recent designs. Some very interesting data concerning the remarkable mileage records made by the balanced compound locomotives on the Atchison, Topeka & Santa Fe Railway are included. Among these might be mentioned engine 509, which was received on May 17, 1904, and made a mileage of 144,927 miles up to October 15, 1906, when it was sent to the shops for tire turning. During this period of 2½ years the engine was out of service only eleven days. The pamphlet also includes a number of suggestions for running balanced compound locomotives. The latter half gives illustrations and dimensions of fourteen designs of balanced compound locomotives built by this company.

NOTES

Wilmarth & Morman Company.—This company, of Grand Rapids, Mich., advises that its shipments for the first seven months of the year exceed those for a corresponding period of last year by 26 per cent.

Ajax Metal Co.—A decision of the Circuit Court of the U. S. District of N. J., was rendered on July 31 in favor of the Ajax Metal Company relative to infringements made upon their patents covering Plastic Bronze. This decision fully sustains all of the claims made by the company.

Pittsburg Filter Mfg. Co.—Mr. L. W. Jones has resigned as president and also from the board of directors of this company and will open an office in Pittsburg as consulting engineer along the lines of municipal and industrial filtration plants, water softening and sewerage disposal plants.

Bliss Electric Car Lighting Company.—Mr. John Reid, who for several years has been connected with the Consolidated Railway Electric Lighting & Equipment Company, has accepted the position of assistant to the vice-president in charge of sales of the Bliss Electric Car Lighting Company, with headquarters at its New York office, Night & Day Bank Building.

American Locomotive Company.—This company has recently received an order of 101 four-wheel motor trucks for the Brooklyn Rapid Transit Company. These will be built to designs prepared by the builder and will follow closely M. C. B. standards, embodying as far as possible the practices of locomotive construction, thereby insuring strength combined with easy riding qualities.

Bliss Electric Car Lighting Co.—This company has received an order from the Baltimore & Ohio Railroad for equipping the Royal Blue limited trains with its system of electric lights and fans. The Pullman Company has also ordered Bliss Axle light equipment to be applied to all Pullman private cars. It is stated that the company has thus far this year furnished more than 75 per cent of the axle light equipments purchased by railway companies.

American Steam Gauge & Valve Mfg. Co.—The Boston *Journal* recently published a reproduction of an advertisement of this company which appeared over 50 years ago. The company were organized in 1854, having purchased the rights to manufacture the Bourdon gauge, and started with a force of three men and seven boys. To-day is has nearly 500 skilled workmen engaged in the manufacture of its well-known gauges, valves and steam engine indicators.

Cincinnati Planer Co.—This company announces that it has increased its capital from $200,000 to $400,000. The additional capital will be used for the construction of a new plant now being built at Oakley, Ohio, near Cincinnati, which will be completely equipped with new machinery and will be used for building the larger size planers. The present plant will be used for the smaller size machines. It is expected that the new plant will be in operation before the first of October.

Westinghouse Electric Company.—Among the large orders received in July by the railway department of this company were two of more than ordinary importance. One of these was from the Brooklyn Rapid Transit Company for 400 electric railway motors, 200 of which are of 200 h.p. capacity for elevated cars and the balance of 60 h.p. capacity for surface cars. The same company will also furnish the multiple unit control system for the elevated equipment. Another large order was from the Schoepf interests of Cincinnati, and included a complete equipment of electrical apparatus for twenty-four sub-stations as well as four Westinghouse turbo-generators aggregating 26,000 h.p.